PERSONALIZED MULTIMODAL URBAN TRAVEL PLANNING

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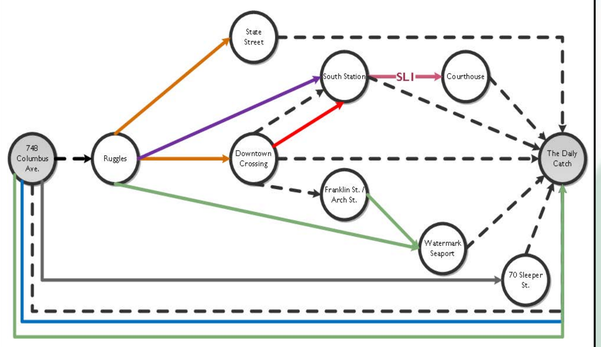
Introduction

- Transportation is constantly growing and evolving to meet the demands of people who want to get where they are going faster
- Need to understand the demands and behaviors of a modern traveler, especially in urban settings where there is a wide variety of transportation options
- Building a multi-modal trip planning tool for the Boston metropolitan area as a case study
- The tool will recommend personalized travel, based on a traveler's preferences surrounding travel time, delays, costs, number of transfers, and comfort

Scope

- There were two case studies conducted: Three-mile and ten-mile case studies.
- Calculate the distance and time between each mode of transportation to compare travel options
- Use a multi criteria decision making tool called Technique for Order Preferences using Similarity to Ideal Solution (TOPSIS).
- Compare multiple alternatives with respect to user input weight for factors including time, cost, comfort, reliability and transfers



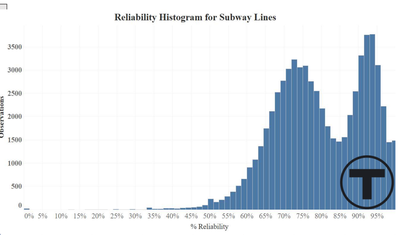
Data Collection & Analysis

Color Key	
Availability	**Metric**
=Data is Available	=Known
=Easy to Access Data	=Estimated
=Unavailable Data	=Historical Insights

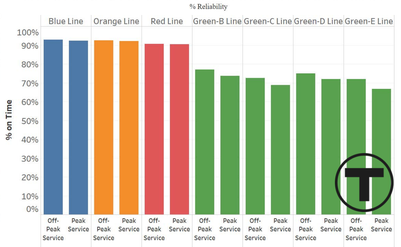
Modes	Delay		Comfort		# Transfers		Cost		Total Time	
	Availability	Metric	Availability	Metric	Availability	Metric	Availability	Metric	Availability	Metric
Walking/ Biking	Google Maps	Zero Delay	Weather Reliability, User Preference	User Preference, Weather Patterns	Calculated	Count of mode transfers	$0.00	$0.00	Google Maps	Average Ti
MBTA	MBTA Performance Dashboard	% on Time	MBTA Reliability, User Preference	User Preference, Ridership	Calculated	Count of mode transfers	MBTA.com	Non-Charlie Card holders Cost	Google Maps	Average Ti
Bike Sharing	Hubway Contact	% Available Bike Stations	User Preference	User Preference	Calculated	Count of mode transfers	theHubway.com	Non-Members Cost	Google Maps	Average Ti
Driving	Traffic Data in Boston	% Late due to Traffic	User Preference	User Preference	Calculated	Count of mode transfers	Estimated by Assumptions	Average Gas Mileage/Parking	Google Maps	Average Ti
Ride Sharing	Uber Movement	% Reliability, % Traffic Delay	User Preference	User Preference	Calculated	Count of mode transfers	Uber App	Average Uber Cost	Google Maps	Average Ti

Month/Name	High Temp	Medium High	Medium Low	Low Temp	Rain	Snow	Fog	Thunderstorm
January	0%	0%	13%	87%	13%	23%	6%	0%
February	0%	3%	38%	59%	34%	28%	14%	3%
March	0%	19%	48%	32%	35%	10%	3%	0%
April	0%	17%	67%	17%	37%	7%	3%	0%
May	13%	61%	26%	0%	42%	0%	0%	0%
June	47%	53%	0%	0%	27%	0%	3%	13%
July	87%	13%	0%	0%	25%	0%	3%	13%
August	100%	0%	0%	0%	32%	0%	0%	10%
September	50%	50%	0%	0%	33%	0%	3%	7%
October	0%	61%	32%	0%	45%	0%	6%	3%
November	0%	20%	67%	13%	37%	7%	7%	0%
December	0%	0%	23%	77%	39%	23%	0%	3%

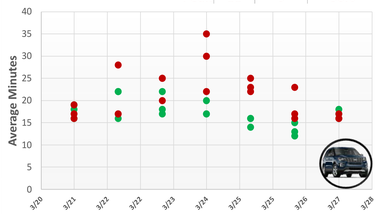
Reliability Calculations

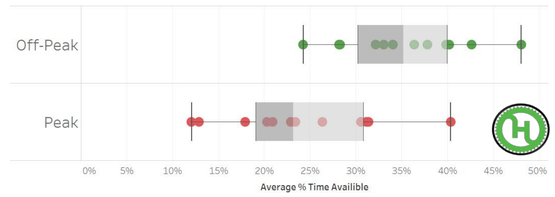


	Commuter Rail	Bus	Subway
Numerator	Number of trains reaching their final stop less than 5 minutes late	Number of time points (key stops) served on time	Estimated number of passengers who waited longer than the scheduled time between trains
Denominator	Total number of scheduled trains	Total number of time point (key stop) observations	Estimated number of passengers waiting at the station
Reliability Metric	% on time	% on time	% of passengers who waited too long



	Mean	Std Dev	% on Time
Off Peak	17	3	81%
Peak	21	5	50%





Methodology

Create a normalized decision matrix, R, using the following relationship

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}}$$

Create a weighted decision matrix, *V,* by multiplying each column of *R* by its corresponding weight, *w:*

$$v_{ij} = (r_{ij})(w_j)$$

Obtain the ideal solution *A** (best possible scenario), and the negative ideal solution *A⁻* (worst possible scenario) from the weighted decision matrix *V:*

$$A^+ = \left(p_1^+, p_2^+, \ldots, p_m^+\right)$$

$$A^- = \left(p_1^-, p_2^-, \ldots, p_m^-\right)$$

Compute the measure of separation from the ideal solution, S_i*, and the measure of separation from the negative ideal solution, S_i

$$S_i^* = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_j^*)^2} \quad i = 1, \ldots, m$$

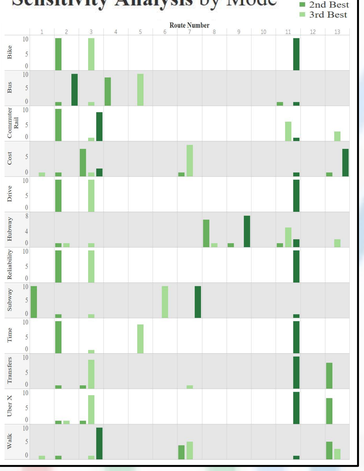
$$S_i^- = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_j^-)^2} \quad i = 1, \ldots, m$$

After obtaining the separation measures S_i^* and S_i^-, calculate the relative closeness, C_i*, of each alternative to the positive ideal solution

$$C_i^* = \frac{S_i^-}{S_i^* + S_i^-}$$

Route #	Time	Cost	Reliability	Transfers	Comfort
1	32	$2.75	97.5%	3	7.80
2	20	$4.25	94.3%	4	5.50
3	26	$2.25	97.4%	3	6.47
4	27	$4.75	95.5%	5	6.58
5	22	$7.50	93.7%	5	7.12
6	28	$5.50	95.8%	4	8.25
7	27	$2.75	97.5%	3	7.80
8	25	$8.75	83.3%	5	6.14
9	30	$6.00	72.5%	3	4.73
10	20	$36.00	90.5%	2	3.65
11	17	$9.19	94.0%	1	7.47
12	20	$0.00	100.0%	1	0.40
13	53	$0.00	100.0%	1	6.90

Rank	Route	Value
1	12	0.97
2	3	0.82
3	7	0.81
4	1	0.79
5	11	0.78
6	2	0.76
7	9	0.75
8	13	0.73
9	6	0.73
10	4	0.69
11	5	0.67
12	8	0.64
13	10	0.32

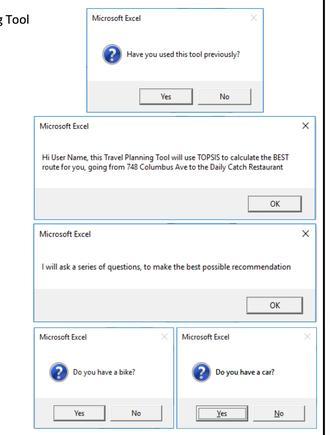


Graphic User Interface

Inputs

Hello, I'm **TOPSY,** your Personalized Trip Planning Tool

TOPSY Stands for:
Travel
Options
Personalzed
Specifically for
You

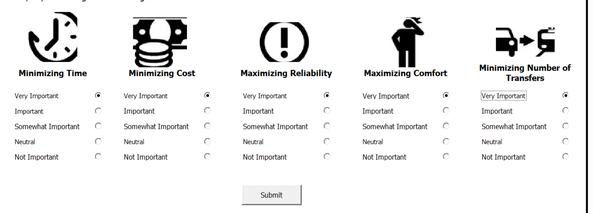


Rate the Following Modes in Terms of Comfort

1 = Not Comfortable **10 = Very Comfortable**

Walking	10	Taking the Subway	10	Ridesharing	10
Biking	10	Taking a Bus	10	Bikesharing	10
Driving	10	Taking a Train	10		

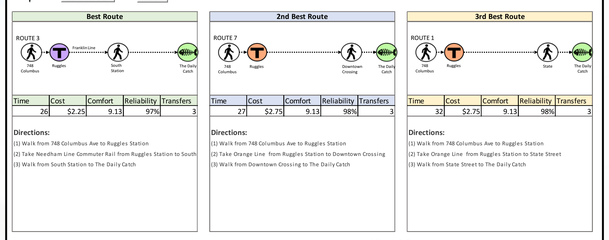
Input your ranking of the following factors:

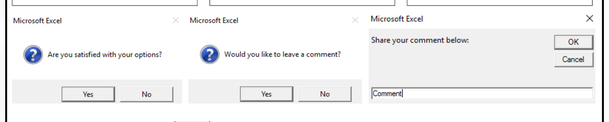


Outputs

Your Personalized Recommendations:

Save Results Return





Historical User Output Percentage Satisfied: 100%

User Info			Recommendation			Verification		Weightings						Comfort Ranking					
ID	Time	Name	Can't Bike?	Best Route	2nd Route	Third Route	Satisfaction	Comments	Time	Cost	Reliability	Comfort	Transfers	Walk	Bike	Drive	UberX	Hubway	Subway	Commu	Bus
1	4/13/17 16:15	Alexa :)	No	No	3	7	3	Yes		5	5	4	2	1	8	1	1	5	1	10	9	5
2	4/13/17 17:03	Bennett Thorson	No	No	3	7	3	Yes		4	4	4	3	3	5	4	9	10	1	6	8	7
3	4/13/17 19:55	Julia Antonino	No	No	3	13	7	Yes		3	5	5	4	2	8	1	1	5	1	8	8	8
4	4/13/17 19:59	Rachel Basso	No	No	3	7	2	Yes	This was lovley.	5	3	3	1	2	9	8	1	9	10	5	6	7
5	4/13/17 20:19	Katie House	No	No	3	7	13	Yes		4	5	3	2	4	6	2	1	9	1	7	9	8
6	4/14/17 12:04	Savannah Greenly	No	No	3	7	1	Yes		5	3	4	4	4	8	1	1	8	1	10	6	3
7	4/15/17 13:22	Marina Eaves	No	No	3	7	1	Yes	It works!	4	5	4	3	3	8	2	10	10	9	7	5	5
8	4/15/17 14:00	James Williams	No	Yes	12	3	7	Yes		4	4	3	2	4	10	10	1	10	7	8	1	7
9	4/15/17 14:03	Ellie Schachter	Yes	Yes	11	7	3	Yes		3	3	5	3	5	10	6	10	9	3	9	3	7
10	4/15/17 14:03	Nasr Al-nasr	No	Yes	12	3	7	Yes		5	5	5	5	5	10	10	10	10	10	10	10	10
11	4/15/17 14:04	Tara McMullin	Yes	Yes	12	3	2	Yes		5	4	4	5	1	8	10	3	3	3	3	4	5
12	4/15/17 14:06	Abdul	No	Yes	11	12	2	Yes		5	1	5	5	5	3	1	10	10	1	3	2	4
13	4/15/17 14:08	Samantha Bell	No	No	3	7	1	Yes		4	4	4	4	4	10	5	10	9	2	10	10	8
14	4/16/17 3:19	Katie House	No	No	3	7	13	Yes		4	5	4	2	4	6	2	1	9	1	7	9	8
15	4/16/17 9:01	aric house	Yes	Yes	12	11	2	Yes	this is asome!!!!#1	5	3	4	3	1	3	5	10	4	1	1	1	1
16	4/16/17 9:05	Dadio	Yes	Yes	10	12	9	Yes	It would take a lot to	5	1	5	5	5	5	10	1	1	1	3	3	3
17	4/16/17 9:08	Abby House	No	Yes	12	13	3	Yes	This was very fast an	3	5	5	5	5	5	5	1	1	5	1	1	1

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Continuation Plan

- Compute travel times using real-time data
- Incorporate machine learning techniques to understand the pattern of an individual user's selection behavior
- Use historical input values to influence the rankings of the routes to further personalize the model output
- Create a more generalized model that could be used to generate route rankings between any two points in the greater Boston area