Public transit accessmap based on Lawrence GTFS data

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Introducation

The public transit accessmap is a further study of the shortest path problem, which is a popular topic in GIS field. The problem's general statements are finding the shortest path length or the fastest travel time between two nodes. Although many shortest path-related researches have been done before, limited research focused on the schedule-based road network's based on GTFS data.

This research choose Lawrence as the study area and designs an adaptive algorithm upgraded from the Dijkstra algorithm to to create the accessmap based on the data collected from GTFS files

Data sources

The road network:

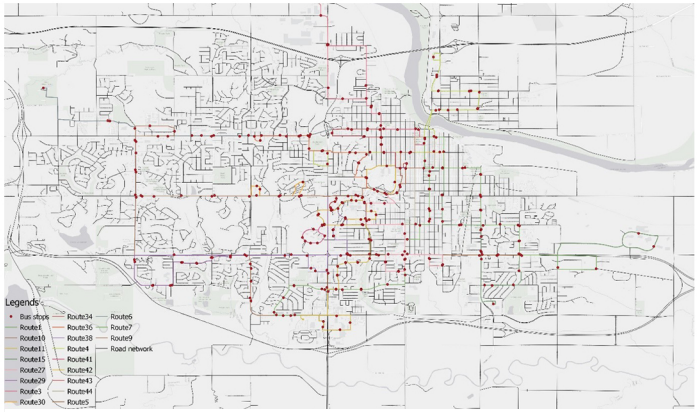
2019 Tiger/Line shapefile product from the US census. bureau website.

The bus transit data:

The city of Lawrence.

The bus schedule and geographic information:

General Transit Feed Specification (GTFS) from Google.



Data manipulation

Multiple steps are needed to convert GTFS data from cvs into the database and fill the uncomplete bus schdule.

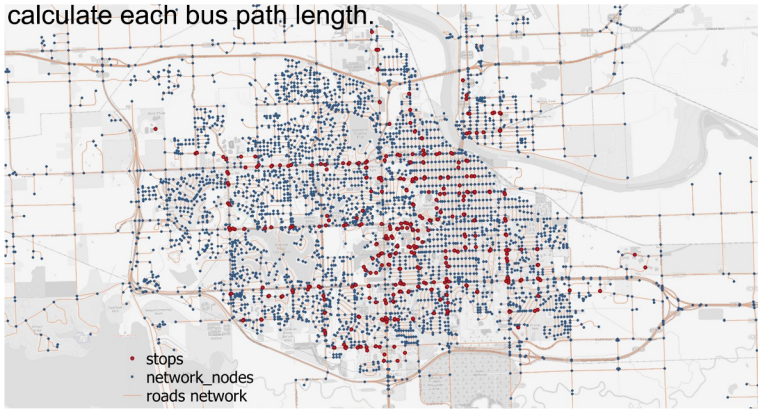
STEP1: Specify each path between two stops with a unique path id. The first stop will not be assigned a path id because the path has a start stop only.

trip_id	stop_id	stop_sequence	path_id
TRIP_1_NB	25TH_FRANKLIN	1	None
TRIP_1_NB	25TH_OCONNELL	2	TRIP_1_NB_2
TRIP_1_NB	23RD_HARP_WB	3	TRIP_1_NB_3
TRIP_1_NB	FAIRGROUNDS	4	TRIP_1_NB_4
TRIP_1_NB	19TH_HARPER_NB	5	TRIP_1_NB_5

trip_id	stop_sequence	path_id	to_stop	from_stop
TRIP_1_NB	1	None	25TH_FRANKLIN	None
TRIP_1_NB	2	TRIP_1_NB_2	25TH_OCONNELL	25TH_FRANKLIN
TRIP_1_NB	3	TRIP_1_NB_3	23RD_HARP_WB	25TH_OCONNELL
TRIP_1_NB	4	TRIP_1_NB_4	FAIRGROUNDS	23RD_HARP_WB
TRIP_1_NB	5	TRIP_1_NB_5	19TH_HARPER_NB	FAIRGROUNDS

STEP2: Topology and calculate bus path length.

Break the road network into multiple lines at points where they meet by pgRouting, which generates a list of nodes and lines. Then, add bus stops as road network nodes. Last, calculate each path length between every two nodes and use pgr_dijkstra to calculate each bus path length.



STEP3: Complete the bus schedule.

With the path length calculated, the speed between schedule stops can be figure out and the bus schedule can be filled out according to the speed and length. The complete schdule can be computed based on the frequency table.

trip_id	stop_sequence	length	agg_len	arrival_time	departure_time	a_time	d_time
TRIP_30_WB_1ST	1	0	0.0	7:10:00	7:10:00	25800.0	25800.0
TRIP_30_WB_1ST	2	314	314.0	NaN	NaN	NaN	NaN
TRIP_30_WB_1ST	3	776	1090.0	NaN	NaN	NaN	NaN
TRIP_30_WB_1ST	4	592	1682.0	NaN	NaN	NaN	NaN
TRIP_30_WB_1ST	5	125	1807.0	7:15:00	7:15:00	26100.0	26100.0

trip_id text	stop_sequence bigint	length bigint	agg_len double precision	arrival_time interval	departure_time interval	end_time interval	headway interval
TRIP_30_WB_1ST	1	0	0	07:10:00	07:10:00	07:35:00	00:20:00
TRIP_30_WB_1ST	2	314	314	07:10:52	07:10:52	07:35:00	00:20:00
TRIP_30_WB_1ST	3	776	1090	07:13:01	07:13:01	07:35:00	00:20:00
TRIP_30_WB_1ST	4	592	1682	07:14:39	07:14:39	07:35:00	00:20:00
TRIP_30_WB_1ST	5	125	1807	07:15:00	07:15:00	07:35:00	00:20:00

trip_id text	stop_sequence bigint	path_id text	f_stop text	t_stop text	d_time interval	a_times interval[]	d_times interval[]
TRIP_30_WB_1ST	1	[null]	[null]	CHELSEA_PL_NB	07:10:00	[null]	{07:10:00,07:30:00}
TRIP_30_WB_1ST	2	TRIP_30_WB_1ST_2	CHELSEA_PL_NB	UNIV_DR_EB	07:10:52	{07:10:00,07:30:00}	{07:10:52,07:30:52}
TRIP_30_WB_1ST	3	TRIP_30_WB_1ST_3	UNIV_DR_EB	BOB_WBROOK_WB	07:13:01	{07:10:52,07:30:52}	{07:13:01,07:33:01}
TRIP_30_WB_1ST	4	TRIP_30_WB_1ST_4	BOB_WBROOK_WB	APPLE_LN_NB	07:14:39	{07:13:01,07:33:01}	{07:14:39,07:34:39}
TRIP_30_WB_1ST	5	TRIP_30_WB_1ST_5	APPLE_LN_NB	14TH_APPLE_WB	07:15:00	{07:14:39,07:34:39}	{07:15:00}

Result

With the complete bus schdule and the upgraded algorithm, an access map is created below. It can be used for many purposes. For example, students who want to arrivel at KU before 8am by bus can find an optimal place to live based on the transit time. Additional requirement can be added such as 5mins walk to bus stops.