Basic Explanation

The goal of this simulation is to see how much time is taken for travelling on the road, dependent on the time of starting. The main effect considered here is traffic, and how it varies through the day - peak time traffic is high, midnight traffic is negligible and so on. Later with successful initial general development and simulation of the model, further exploration on the effect of different model parts like road length and peak traffic size will be done.

This first part of the file is to plan out the model.
We assume a 3 part road (with non-equal but unchanging length), each with a constant average speed. This speed is traffic dependent - more traffic, less speed. This speed also changes depending on time of day - peak time, less speed.

We divide the roadway into a 3 part one as it comes from the observation of drivers such as myself. At first roads are light, then traffic builds up, then again becomes light. We will assume that the 2 end sections of the road are of equal average speed.

We model the road traffic as just an effect on average speed. No modelling on actual starting & stopping, and other effects will be done, for simplicity.

With that, let us go into modelling details. The vehicle is modelled as an entity with trip start time, trip end time and a particular distance to cover. It will be simulated through the road-way. The "inputs" we give, are basically the starting time.

The next thing is to model the road way. The length will be:
Road1:5 km
Road2:15 km
Road3:5 km
Total length is same, 25 km

Now comes the modelling of traffic. As said earlier here, the traffic isn't being modelled as is; instead the effect of traffic on average speed on the roadways are done. Therefore, mathematically:

Average speed for a roadway = function (traffic at the time)

This is the same thing as saying the average speed for a particular point in the roadway can be obtained from the traffic density using mathematical calculations.

The definition of this function is needed to be done first. It is challenging, and there are no ready-made formulas, as is common in studies of human behaviors. Nevertheless some simple reasonable assumptions will be made, to make sure there is no unnecessary effort done.

For the purposes of simulation, traffic peaks around 5-7 pm, with a proper peak at 6 pm. This can be changed later as well.

Now we define 5 different traffic categories, and the speeds that ultimately result. If smaller section is denoted as S, and larger section as L, the average speeds in kmph are in different traffic qtys:

Low traffic = S-80, L-100
low-med trfc = S-70, L-80
med trfc= S-60, L-60
med hi trfc= S-50, L-40
hi trfc = S-40, L-25

These nos. are based on inaccurate observations as per the author's experience - some changes in nos. may be seen later. These nos. are not absolute.

The simulation will be with a time step of 10 min. A math function gives an average speed for that block of 10 min, based on the above categories and some mathematical calculations (basically a polynomial interpolation for those points for those who know). The speed changes every ten minutes, and is constant for that 10 min.

So the flow of simulation is:

1. Give a starting time

2. Calculate average speed for next 10 min.

3. Derive a distance covered for those 10 min with that speed-keeping that speed constant.

4. Add that distance to a running counter for the distance. Add the time to a separate running counter for time as well.

5. Recalculate the speeds for the next 10 min

6. Compare the distance counter with the roadway length. Check if the roadway section can be covered in that 10 min slot. If yes, then do these:
    6a. calculate time to finish the road section.
    6b. once covered, change speed as per road section - as per above data
    6c. then with remaining time, calculate distance again with the speed of the new road section

7. If for the time block of 10 min, if the road ends and destination is reached before the 10 min, calculate the time needed to finish the journey, and add that time (not 10 min) to the time counter.

8. Report the time counter value as the time for the entire journey. Optionally, you can report the time for completing road sections and the entire graph of distance vs time as well.

9. Repeat the above, till the complete trip is complete.

So you can see: The goal is to find the time (with time counter), and use the distance counter for changing and stopping the simulation.

Implementation details:

Time calculations:
If this program is to be of benefit to the people suffering with traffic, the time format should be the HH:MM format. However, this format is inconvenient for calculation. Therefore a program for conversion will be done.

Therefore we define two equivalent times in different formats: human-time as = HH:MM, where HH is between 0 and 12 and MM is between 0 to 60
Computer-time as just MM minutes, where MM is from 0 to infinity

All calculations are done in calculation time. Only the final reporting of times will be done in human time

Traffic-Time-Speed modelling:
The speed vs time-of-day can be any math calculation. However, here we will start with a simple linear function.
Therefore we define for the following – we care only about the evening for now:

Time of day	Traffic level	Small section spd	large section spd
12 noon	low	80	100
2 pm	Low-med	70	80
4 pm	Med	60	60
6 pm	High	40	25
8 pm	Med-high	50	40
10 pm	low-med	70	80

At first we will use a polynomial approximation (cubic) using scipy

Pseudocode – Phase 1:

Class car:
    Initialize:
    Calc-time-start = starting time in computer time – to be obtained from “starting time” as below
    Calc-time-now = current time in computer time– to be initialized from “starting time” as below

Calc-time-done = time for trip currently in computer time
Distance travelled – current completed travel distance – default zero
Trip or total distance – to be obtained from the “Sections” dictionary as below
Section – current section of the vehicle - default 1
Last section – default 1 – to be obtained from the “Sections” dictionary as below

Function:
To Convert from human time to calculation time
To Convert from calculation time to human time
To calculate the distance to current section from previous section

Program variables:

1. Starting time - in hours and minutes (human time).
2. Sections: python dictionary as “section number (integer): section length (float)”
3. Time Block = step time for simulation = default 10 min

Calculations program:
Start:
While the car is still in the trip – loop 1:

1. Get the speed at time-of-day
2. Calculate distance in km for next 10 min – store this separately
3. Check for completion of trip – how: if car is in last section and trip distance is complete:
    a. If yes:
        i. Then check the distance left
        ii. Calculate the time left to complete that distance in that trip – time_2
        iii. Add the time “time_2” to the counter
        iv. Get out of loop-1 (use “break” statement)
    b. If no: continue in loop
4. Check for completion of section – how:
    a. If yes:
        i. Then check the distance to next section
        ii. Calculate the time to cover that distance – store in time_1
        iii. Increment the counters for time and distance
        iv. Change section – how: increment the section
        v. Go to next iteration of loop 1 (use “continue” statement)
    b. If no:
        i. Continue in loop-1
5. Add distance to the distance counter and time (=10 min) to the time counter
6. Restart loop-1

Development of Project:

Phase 1: development of the code for car variables and calculation of distances and times, as well handling end-cases. Simulation will be done for a constant traffic-vs-time of day scenario for basic testing

Phase 2: development of code for developing the speed vs time-of-day mathematics.

Phase 3: development of code to see the effect of different starting times on journey lengths

Phase 4: to see the effect of different traffic modelling and so on

Phase 5: planned, to see the effect of different cars on different roads

Log of progress:

- Phase 1 started in planning stage on 14 Aug 2018
- Basic documentation for variables, algorithms and phases of the project was done on 19 August 2018, 10 am
- Phase 1 started in coding stage on 19 August 2018, 12 noon
- Phase 1 completed as of 19 August 2018, 6 PM. The phase consisted of:
    - Code for the “car” class, complete with time data, distance data and section data as required
    - Working code for the calculation of the times through all sections of a roadway, with the help of the time step.
    - Additional program variables such as starting time in HH:MM and sections (Python dictionary with section no. and section length in km) must be mentioned. Here there is no validation of this data; care must be taken here. Future phases/sub-phases may take care of these
    - The result, which should give the time-of-trip, are sensible and the program can be trusted to work under reasonable and valid inputs

- The next phase – Phase 2 – will include the coding for the modelling of traffic and the subsequent speed