Characterising Eco driving with GPS and CANBus data

Karsten Jakobsen
Institute of Computer Science
Aalborg University
Denmark
karstenjjakobsen@gmail.com

Sabrine C. H. Mouritsen
Institute of Computer Science
Aalborg University
Denmark
sabrinechm@gmail.com

1. DATA DESCRIPTION

A number of data sources can be used to gather data. GPS data can easily be collected from any vehicle equiped with a GPS system, through which for example a timestamp, longitude, latitude and speed are available. CANBus data provides information about the state of the vehicle. Retriving CANBus data is not as easy as GPS data, and little data is therefore avialable. CANBus data is for example the engines rounds per minute, fuel consumption and temperature. The hauliers may also provide additional information such as vehicle model, capacity and weight.

Table 1 lists the data columns in the provided data set. The data set contains 10,224,846 records collected from 6 minibusses. All vehicles are assumed to be compareable.Instantaneous fuel consumption is undependable and should not be used and non of the data provided by the haulier is available. totalconsumed is the most accurate measure for fuel consumption, however, it only has a granularity of half a liter. Therefore, it can only be used at an agreegated level of at least a trip.

Name	Data type	Source	Description
vehicleid	integer	ID	Unique identifier for veh
timestamp	timestamp	GPS	Date and time of the rec
longitude	float	GPS	Longitude coordinate of
latitude	float	GPS	Latitude coordinate of t
speed	float	GPS	Driving speed in km/h
direction	integer	GPS	Direction of the vehicle
satellites	integer	GPS	Number of visible satelli
rpm	integer	CANBus	The engines rounds per
kmcounter	float	CANBus	Mileage record
temperature	float	CANBus	Temperature of the engi
fuellevel	float	CANBus	Fuel level in the tank wh
throttlepos	float	CANBus	Position of the throttle.
totalconsumed	float	CANBus	Total amount of fuel con
actualconsumed	float	CANBus	Instantaneous amount o
actual_km_l	float	CANBus	Instantaneous km/l. Un
acceleration	float	CANBus	Acceleration ???
make	integer	Haulier	The make of the vehicle
model	integer	Haulier	The model of the vehicle
capacity	float	Haulier	Number of possible pass
weight	float	Haulier	The weight of the vehicl

Table 1: GPS and CANBus data types

2. DEFINTIONS

2.1 Trips

The provided data set is annotated with a trip identifier, *tid*. A trip is defined as a collection of records with the same vehicle identifier, *vid*, and where each two consecutive records are within 100 seconds of each other. A trip is hence defined from when the vehicle is turn on and not by when the vehicle is moving when it is possible to map-match GPS coordinates to road segments. This defintion is chosen as idle time, i.e. when the engine is running but the vehicle is not moving, is persumed to be an important factor for fuel consumption.

The data set contains 13606 distinct trips containing between 1 and 78511 records. Many of these trips have less than 100 records and are therefore not useful. We remove these trips which results in 2868 distinct trips. The longest trip is 231 km and 278 trips drive less than 1 km.

2.2 km per liter

Km per liter is the total number of kilometers driven in the trip divided by the amount of fuel used. The fuel consumption is extracted from the totalconsumed column which gives the most accurate consumption of the available data.

All six vehicles in the data set have similar km/l accross their trips (See Figure 2). Most trips are driven with bewteen 5 and 10 km/l and all have trips with 0 km/l. The latter is because they do not drive any where.

Km per liter can be used as a measure for how fuel efficient the vehicles are. We classify the trips into three classes based on their km/l. Class 'low' contains trips with between 0 and 4 km/l, being all those that fall below the normal values. Class 'medium' contains trips with between 4 and 8 km/l and class 'high' contains the remaning trips with 8 or more km/l. The main cluster is split into two classes to distinguish the best trips.

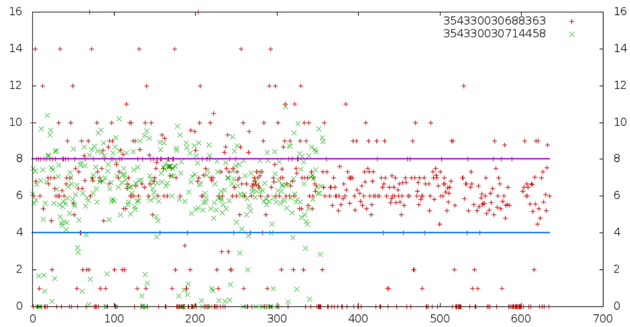

Figure 1: km/l for all trips

3. MEASURES

3.1 Idle

We define idle time to be the time where the driver might as well have turned off the engine. When a vehicle is decelerating with the clutch down the RPM of the engine will drop to idle, however, the driver may not turn of the engine of in this situation as he would lose power, stearing and break assistance. The avarage lowest RPM is 800-850 RPM. We therefore define idle state as when the speed of the vehicle is less than 10 km/h and the RPM of the engine is less than 900.

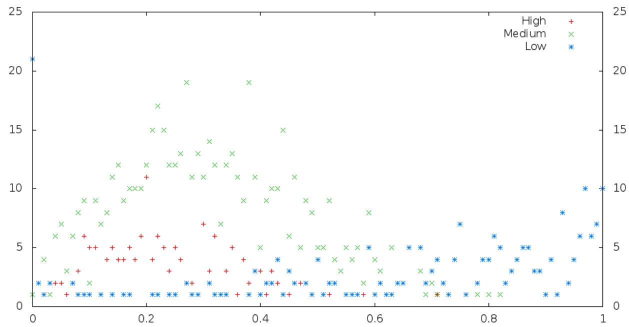

Figure 2: Idle time all trips

3.2 Cruise

[] establishes that driving at a constant speed is more fuel echonomic. From observing data with and without the driver using cruise control we find that the speed varies ± 1km/h. An experienced driver can drive at a constant speed without cruise control but the speed will generaly vary more. We define a vehicle as cruising if it in a 40 second period drive with a constant speed ± 1km/h.

3.3 acckm

Acckm capture the sum of accelerration a vehicle perform on a trip. [] establishes that accelerrating consume extra fuel. A trip with a low accelerration should use less fuel. To normalise acckm we divide it by the lenght of the trip. Acckm is caculated in Algorithm 1. A buffer (dotted line) as shown in Figure 4 is implemented to prevent small variaction in speed (solid line) to effect the acckm

3.4 Stop and go

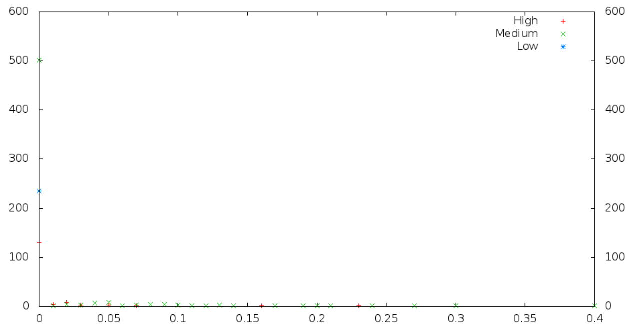

Figure 3: Cruise all trips

Algorithm 1 *acckm*

$temp = 0$
$counter = 0$
$buffer = 5$
while $i < n$ **do**
  if $v_i - v_{i-1} > buffer$ **then**
    $counter += (v_i - v_{i-1}) - buffer$
    $temp = v_i - buffer$
  else if $v_{i-1} - v_i > buffer$ **then**
    $temp = v_i + buffer$
  end if
  $i += 1$
end while
return $counter/trip_{length}$

Stop and Go represent the number of times a vehicle perform a full stop and go normalised over the lenght of the trip. A full stop is defined as a vehicle speed faling below 10km/h, and a go is defined as when the speed rise above 15km/h.

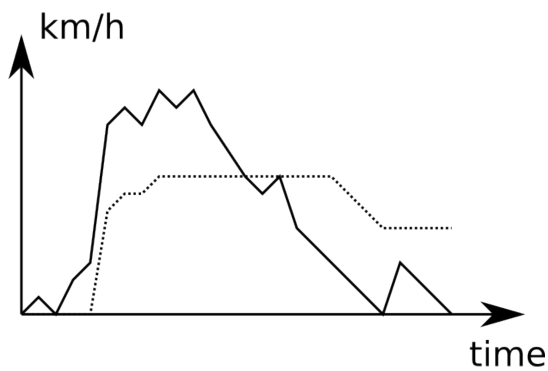

Figure 4: Acckm

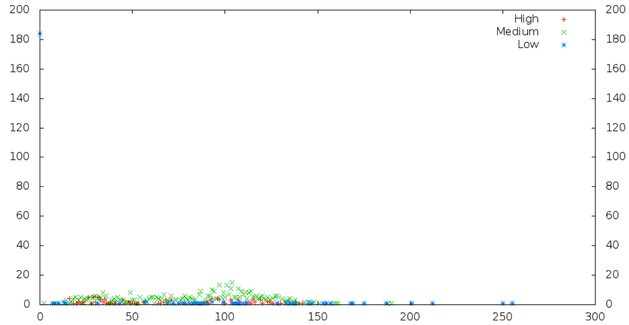

Figure 5: Acceleration km all trips

../src/images/stopngoTrips.png

Figure 6: Number of stop and go's all trips