CALIBRATED ROUTE FINDER
– AN OBJECTIVE AND EFFICIENT AGREEMENT ON TRANSPORT DISTANCE BETWEEN HAULERS AND CUSTOMERS



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Abstract

In Sweden forest road transport payment is based on the distance driven. Historically, many different means of establishing this distance exist, with the consequence that a given assignment can be invoiced differently. The distance is also often determined manually, leading to unnecessary administration. Hence, there is a need for an objective and automatic routine that the parties on the forest transport market could agree upon. Since 2008, a system called Calibrated Route Finder has been in practice in Sweden. In the approach to establish the preferred route distance nine road features and weights for 56 attributes are used. To find accurate weights, "key-routes", are used as the optimal solution of an inverse minimum cost model. Deviation reports by the transporters point at development needs. One example is curvature and topography, increasing both time and fuel consumption. The impact of introducing features describing these conditions has been examined with encouraging results and was recently implemented. At the moment (June 2014), 43 % of all invoicing is based on the distance from this system.

Keywords: Calibrated Route Finder, Key Routes, Forest Road Transport, Invoice, Inverse Minimum Cost Model, Optimization, Road Feature, SDC, NVDB, SNVDB

1. Background

In Sweden forest road transport payment is based on the distance driven. The annual transportation cost in Sweden during 2011 by logging trucks was about US 800 million. The volume harvested was 73 million cubic meters transported by 1.7 million truck loads. Each of these truck loads had an average transportation distance of 98 km and each truck load requires an invoice as the basis for the payment transaction. Historically, many different means of establishing this distance exist, with the consequence that a given assignment can be invoiced differently. The distance is also often determined manually, leading to unnecessary administration. Hence, there is a need for an objective and automatic routine that the parties on the forest transport market could agree upon.

Since a few years back, a system called Calibrated Route Finder has been in practice in Sweden. It is administrated by SDC, a central organisation in Sweden often called the IT hub of Swedish forestry. SDC manage and administer all the forestry transportation data in Sweden. They act as an independent organisation to ensure that correct information is used in the invoice handling between forest companies and transportation organisations. From the homepage of SDC or through automatic connections, companies can access the routing system to find the correct distance for invoicing. It is also a possibility to look at the proposed trip.

2. The Swedish road database SNVDB and distance calculations

SDC is also responsible for maintaining the forestry version of the National Road Database, SNVDB, which is retrieving information from NVDB, the Swedish National Road Database. NVDB was developed in collaboration between the Swedish National Road Administration, the Central Office of the National Land Survey, the Swedish Association of Local Authorities, and the forest industry. The database contains digital information about all Swedish roads: the state road network, the municipal road and street network, and private road networks. All roads, approximately 560,000 km, are described geometrically, topologically, and with detailed information about each road segment. During the past decade, the Swedish forest companies have made large investments in order to collect all the necessary data.

To use the SNVDB it is first necessary to convert the basic data from the database into a network of nodes and arcs. Currently this network consists of about 2.20 million nodes and 4.43 million arcs. In the approach to establish the preferred route distance nine road features are used. Within each feature there is a set of attributes. The total number of attributes (with a weight in the distance computation) is 56. Table 1 provides a summary of the features and attributes used so far in the system. Each of these attributes requires a unique weight in the distance calculations.

Table 1 - Summary of road features and attributes used in the project

Id	Feature	No. of	Comments

		attributes	
1	Bearing class	4	Bearing capacity of road (truck weight)
2	Terrain class	5	Suitability of different truck types
3	Road class	10	Classification of road quality from European motorways to small forest roads
4	Maximum speed	13	Different speed limits
5	Road width	16	Division in 0.5 meters
6	Owner	3	Government, municipality or private
7	Timber route	2	Special forest route
8	Passing route	3	Special route in cities through/around city centre
9	Length	1	Length

To find the weight for the attributes there is a use an inverse optimization approach. This involves establishing a set of routes, called "key-routes", agreed by all parties. These are then used as the optimal solution of an inverse minimum cost model. The main decision variables are the weights and the objective is to maximize the number of key-routes generated as solutions from minimum cost route problems with the found weights. A more detailed description of model, method and analysis is found in Flisberg *et al.* (2012).

3. Results and use

Since 2008, we have established and put in operation a number of weight settings in the SDC online system. The number of road features and attributes has increased during the project as routing results have been studied by a project board as well as forest companies and transporters. In addition, a number of mechanisms to control the route selection have been included. One example is passing routes to avoid traffic in cities and another is so-called "approach routes" to industries. If an industry is situated in a town, a local requirement is often to follow a particular (approach) route. During 2009-2010 a prototype testing was done and evaluated at six companies located in different parts of Sweden. Each of the six companies selected a smaller district in which to test the system in practice. The result of this prototype testing was very good and several companies have decided to implement the system for all their operations. We have also compared reported distances to SDC during a ten-month period in 2008 which covered all invoiced routes (more than 1.2 million). Since then, the system has been in full production to support participating companies. At the moment (June 2014), 43 % of all invoicing is based on the distance from this system. The vision is 100%.

Now and then the Calibrated Route Finder is suggesting routes that are not the best ones. In these cases the hauler can create a deviation report. These reports point at deficiencies and development needs. Two of the most occurring complaints are that the route has too much curvature or has too much work going up and down. Both these obviously increase the fuel consumption and the drivers need to be more observant. The impact of introducing a feature describing curvature and hilliness has been examined with encouraging results and it was recently decided to be implemented. A key question is whether or not it is possible to get this information to measure the curvature. Each road segment (link in the network) is given as a point sequence with horizontal and vertical coordinates. With this geographical information as a basis, it is possible to establish a curvature value. Truck drivers also avoid driving on roads with many hills, as it results in increased fuel consumption. However, the vertical coordinates are currently not of the same quality as the horizontal ones. There is a process under way to make information from high-quality aerial surveys available in SNVDB. When this work has been completed, it will be possible to compute the vertical work accurately too. In October 2013 it was decided at SDC to include curvature and hilliness as new attributes. In the presentation, we will discuss some preliminary findings and describe the implementations into a working system.

4. References

- Flisberg, P., Lidén, B., Rönnqvist, M. & Selander, J. 2012. Route Selection for best distances in road databases based on drivers' and customers' preferences, Canadian Journal of Forest Research, Vol 42, No 6, 1126-1140.