QBENCH

Calculation details

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1.1 QBENCH method, cost function and quality of traffic information

Prior to calculation, the following definitions are fixed:

times are seconds, lengths and distances are meters
test route = S; length of route = d
freeflow speed = v_{ff} ; freeflow traverse time = t_{ff}
ground truth speed= v_{gt}; ground truth traverse time = t_{gt}
reported speed = v_{rep}; reported traverse time = t_{rep}
stand still (lowest possible speed) speed = v_{ss}; stand still traverse time = t_{ss}
congestion threshold t_{ct} or v_{ct} respectively

The Ground truth information can be derived from standard sampling technique or test drives with GPS tracks.

1.1.1 Eliminate Extremities

Speeds are adjusted to the defined boundaries stand still speed and free flow speed limit:

If $v_{gt} \geq v_{ff}$ then set $v_{gt} = v_{ff}$. If $v_{rep} \geq v_{ff}$ then set $v_{rep} = v_{ff}$.
If $v_{gt} \leq v_{ss}$ then set $v_{gt} = v_{ss}$. If $v_{rep} \leq v_{ss}$ then set $v_{rep} = v_{ss}$.

Calculate t_{gt} and t_{rep}.

1.1.2 Adjust speeds and apply tolerance

If the reported speed is within this tolerance of the ground truth (e.g. 15% v_{gt}) speed, then set the reported speed to be equal to the ground truth speed.

$$t_{lower} = \frac{3.6d}{1.15v_{gt}}$$
$$t_{upper} = \frac{3.6d}{0.85v_{gt}}$$

If $t_{lower} \leq t_{ff}$ then set $t_{lower} = t_{ff}$. If $t_{upper} \geq t_{ss}$ then set $t_{upper} = t_{ss}$.
If $t_{lower} \leq t_{rep} \leq t_{upper}$ then set $t_{rep} = t_{gt}$.

1.1.3 Check congestion threshold

If both the ground truth and reported speeds are above the congestion threshold then both the ground truth and reported speeds should be set to the free flow speed (e.g. 50% v_{ff})

If both $t_{gt} \leq t_{ct}$ and $t_{rep} \leq t_{ct}$ then set $t_{gt} = t_{ff}$ and $t_{rep} = t_{ff}$.

1.1.4 Calculate ideal Benefit

The ideal benefit is calculated as the number of seconds of delay which should be begin reported by Partner – this value is scaled by φ (e.g. φ=2).

$$B_{ideal} = \begin{cases} 0 & , t_{gt} \leq t_{ct} \\ (\varphi - 1)(t_{gt} - t_{ff}) & , t_{gt} > t_{ct} \end{cases}$$

1.1.5 Calculate B_{Loss} based on reported speed

If the reported speed is outside the tolerance area, the actual benefit will be reduced.

The loss associated with overstating and understating the speed is different. If the reported speed is free flow, the Benefit is set to zero.

$$B_{loss} = \begin{cases} (\varphi - 1)(t_{gt} - t_{rep}) & , t_{rep} < t_{gt} \\ 0 & , t_{rep} = t_{gt} \\ t_{rep} - t_{gt} & , t_{rep} > t_{gt} \end{cases}$$

1.1.6 Removing Discontinuity

To remove the jump in penalty at the border of the tolerance area, the boundary benefits B_{lower} and B_{upper} are calculated.

$$B_{lower} = B_{ideal} - (\varphi - 1)(t_{gt} - t_{lower})$$
$$B_{upper} = B_{ideal} - (t_{upper} - t_{gt})$$

1.1.7 Calculate Benefits; B_{actual}

Using the new border Benefits, the actual Benefits can be calculated.

$$B_{actual} = \begin{cases} \left(\frac{B_{ideal}}{B_{lower}}\right)(B_{ideal} - B_{loss}) & , t_{rep} < t_{gt} \\ B_{ideal} & , t_{rep} = t_{gt} \\ (B_{ideal} - B_{loss}) + (B_{ideal} - B_{upper}) & , t_{rep} > t_{gt} \end{cases}$$

1.1.8 Apply Capping

To limit the impact of single events to the overall value, capping is applied to the Benefits B_{ideal} and B_{actual}.

The capped value B_{cap} is defined as

$$B_{cap} = \lambda * (\varphi - 1) * \left(\frac{100}{\delta} - 1\right) * t_{ff}$$

Where δ is the percentage of free flow speed for a segment below which it is considered congested, and λ is the number of times the minimum congestion would have to be reported correctly in order to counter the effect of missing the worst case congestion. These values differ for motorways and non-motorways.

Capping is applied by changing B:

$$B_{ideal} = \begin{cases} -B_{cap}, & B_{ideal} < -B_{cap} \\ B_{ideal}, & -B_{cap} < B_{ideal} < B_{cap} \\ B_{cap}, & B_{ideal} > B_{cap} \end{cases}$$

Similarly if the actual benefit for the section exceeds the cap then set it to the capped value

$$B_{actual} = \begin{cases} -B_{cap}, & B_{actual} < -B_{cap} \\ B_{actual}, & -B_{cap} < B_{actual} < B_{cap} \\ B_{cap}, & B_{actual} > B_{cap} \end{cases}$$

1.1.9 QBENCH

The final QBENCH calculation is given by summing all the actual benefits for the reported speeds and dividing by the sum of all the ideal benefits.

$$QBench = \frac{\sum_{all\ S} B_{actual}}{\sum_{all\ S} B_{ideal}}$$

1.2 Definitions

1.2.1 Freeflow speeds

Freeflow speeds will be set to the speed limit on all sections of road except those where the road is non-restricted and in an urban area where the freeflow speed shall be set to e.g. 80% of the speed limit. This is to take into account the likely effect of road topology including traffic lights, roundabouts, pedestrian crossings, etc.

1.2.2 Tolerance

A tolerance area is defined where the reported speed is set to the ground truth speed if inside the area. This covers natural variances within travel speeds. Since variation is speed dependent, the tolerance shall be a percentage of the Ground Truth speed.

1.2.3 Congestion threshold

The congestion threshold speed is defined as the road speed over which each driver effectively has a free choice as to their choice of speed, up to the speed limit (if there is one).
The congestion threshold for the different road classes is defined by a certain percentage of the freeflow speed, e.g. 50%.

1.2.4 Standstill speed

The standstill speed is set in all cases to a fixed value. All speeds below that limit are set to e.g. 3kph.

1.2.5 Windowing function

To better adapt to inner city conditions where traffic lights affect travel time apart from traffic congestion and also to remove lane dependency, a rolling window mechanism was developed.
Travel times from probes and reported times from the service provider are aggregated over a defined window size. The weighted average is then used for calculation of QBench.
The window is then moved by a specific length which is lower than the window size.