Methodology for evaluating cost and accuracy of parking patrol surveys

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Problem Statement

Patrol Survey

Patrolling observers check the parking area every δ minutes and record parking information, in order to find the average parking duration $\overline{T}$. However, the estimated value $\hat{\overline{T}}$ is biased and accuracy is unknown to the surveyor.

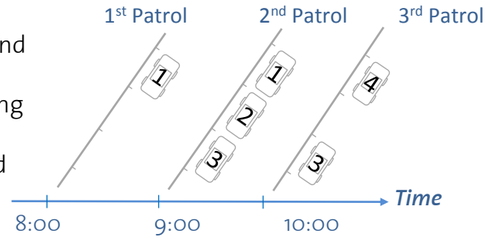

Figure 1. Patrol survey at same location (δ=1 hour)

Biased Data

- Short duration parkers are under sampled
- Estimated duration of observed vehicle is imprecise

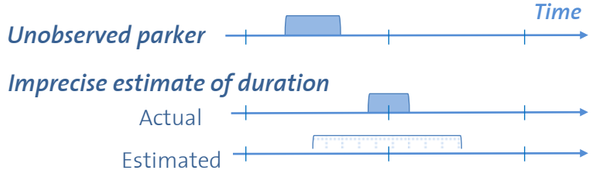

Figure 2. Example of biased data collected in the survey

Research Questions

As the accuracy is unknown, it is impossible to evaluate the survey. However, very often, a trade-off between accuracy and survey cost must be made.

1. Is the survey result usable?
2. What is the survey accuracy ?
3. Is it worth to invest more money?
4. How to obtain high quality results from the patrol survey while keeping costs to a minimum?

Solution

Methodology and Results

i. Define three dimensionless variables
   - *X - survey intensity*
   - *Y - survey error*
   - *Z - relative cost*

ii. Identify relation between X, Y and Z for the three most typical distributions of parking duration:
   - Uniform
   - Gamma
   - Hyper- exponential

   The shape of the curves are quite similar, the result based on gamma distribution are presented.

iii. Build an analytical model, extend it with simulations, and validate it with read data.

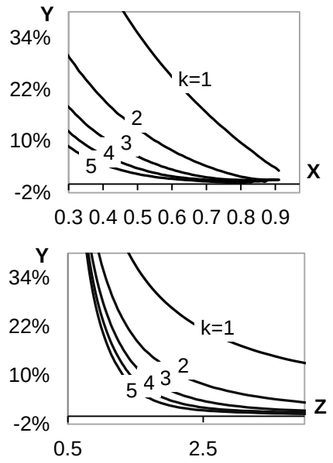

Figure 3. Relation between X, Y, Z (k is the shape parameter of gamma distribution)

Validation

Data from two parking garages are used:
- Ballston garage (2800 stalls)
- Max-bill-Platz (60 stalls)

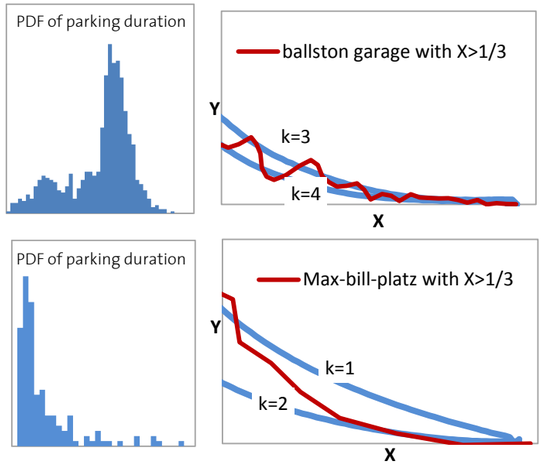

Figure 4. Relation between survey error (Y), and survey intensity (X) using real data

Solutions/ Conclusions

With this method:

1. An estimation system is provided for patrol surveys
   - One can find out if the result is usable (the value of survey intensity X must be greater than 1/3).
   - One can estimate the accuracy given the survey data.
2. One can recommend the minimum budget to guarantee results with predictable accuracy.
3. One can estimate the gain in accuracy that could be achieved by increasing the budget.
4. One can correct the results, so a higher accuracy can be achieved with a lower budget.

Application Example

In the case of Max-bill-platz, it is possible to keep the survey error at 6% with a budget of only 109 units using our method (only need to assume a lower bound of $\overline{T}$), while a budget of 150 units would generate an error of 18% when using the traditional method.

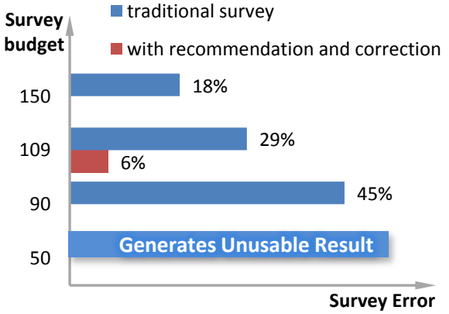

Figure 5. Application example obtaining high quality results with low budget