Optimising road selection for small-scale maps using decision tree-based models

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Motivation

- improving road selection for small-scale maps
- exploring new variables, important in road selection
- receive the automatic selection results, which are closer (similar) to manual map design
- expanding the approach proposed for automated settlement selection (Karsznia & Weibel 2018, Karsznia & Sielicka 2020) on road network.
Related works

- Various methods of road network generalization: graph-theory-based methods, stroke-based methods, methods based on information theory, various other measures (Richardson & Thomson 1996; Jiang & Claramunt, 2004; Liu et al., 2010; Touya, 2010; Benz & Weibel 2014).

Scope of the research

Poland
Research methods

- road data enrichment,
- decision trees (DT),
- decision trees supported with genetic algorithms (DT_GA).

source: https://tinyurl.com/yyyyf2lww
Schema of the research methodology

Regulation → GGOD → selection → visualization → validation

basic approach

enhanced approach

Atlas Map

Machine learning → selection → visualization
Variables. Basic approach

- road class (highway, expressway...)
- road category (national, voivodeship, district...)
- type of surface (paved/unpaved)
- number of lines
Variables. Enhanced approach

- road class
- road category
- type of surface
- no. of lines
- no. of connected roads
- no. of settlements connected to the network segment
- no. of roads connected to network segment
- minimum no. of segments from settlement, which is connected to road segment
- length of road segment
- betweenness centrality measure

Rocks density:
- paved roads in hexagons
- paved roads in districts
- all roads in hexagons
- all roads in districts

marked blue – newly introduced variables
## Results

<table>
<thead>
<tr>
<th>area</th>
<th>basic approach</th>
<th>enhanced approach</th>
<th>difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>all districts</td>
<td>45,10 %</td>
<td>64,61 %</td>
<td>19,51 %</td>
</tr>
<tr>
<td>Białostocki</td>
<td>43,70 %</td>
<td>61,19 %</td>
<td>17,49 %</td>
</tr>
<tr>
<td>Rzeszowski</td>
<td>55,25 %</td>
<td>72,97 %</td>
<td>17,72 %</td>
</tr>
<tr>
<td>Kępiński</td>
<td>42,10 %</td>
<td>65,35 %</td>
<td>23,25 %</td>
</tr>
</tbody>
</table>
Decision tree for all three districts.
Result of machine learning

- **road category**
  - other or main
  - district
  - voivodeship or national

- **no. of connected roads**
  - less than 4
    - omit
  - 4 or more
    - select

- **select**
Selection results in Białostocki district

Note that the settlement layer for basic and enhanced approach comes from previous research by Karsznia & Sielicka (2020)
Selection results in Kępiński district

Note that the settlement layer for basic and enhanced approach comes from previous research by Karsznia & Sielicka (2020)
Selection results in Rzeszowski district

Note that the settlement layer for basic and enhanced approach comes from previous research by Karsznia & Sielicka (2020)
Discussion and conclusions

- The use of DT and DT_GA made it possible to observe the decision process and explore important variables (road category, no. of connected roads),
- the use of ML models made it possible to improve the accuracy of selection compared to the solution applied in the basic approach (difference for all districts - 19.52%),
- in all tested cases the selection results are more similar to the selection on atlas reference map,
- in Rzeszowski district, the visual inspection shows that the road network is too dense comparing to the atlas map, however, on the contrary to the atlas map, it is consistent.
Future research

- Extending the data sample on further districts to receive more rich, complex but more holistic decision trees.
- Using other machine learning models to further optimise selection and to achieve better performance.
- Including other topological measures concerning road network to better characterise road network.
- Evaluation of the achieved results with the support of experienced cartographers.
Thank you for your attention

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