Metrics to Rank Illegal Buildings

Paolino DI FELICE
paolino.difelice@univaq.it
0000-0003-3552-0199

Dep. of Industrial & Information Engineering & Economics
University of L'Aquila, L’Aquila (ITALY)
DATA ANALYTICS 2021
October 03--07, 2021 - Barcelona, Spain
The campus of the Department of Industrial & Information Engineering & Economics University of L'Aquila, L'Aquila (ITALY)

Current research interests:
- Ranking Strategies;
- Informative Marketing;
- Model-driven Engineering;
- Automatic Code Generation of MVC Web applications;
- Quality Metrics;
- Metadata Repository;
- Reuse of UML Artifacts;

This is me
PRELIMINARY CONSIDERATIONS

An image of the flood of Florence (1966)
The Italian Law n.42 (Jan., 2004).
Art.142:
fixes in 150m (both sides) the width of the Band of Respect around rivers.
SPEECH’S OUTLINE

✓ Problem relevance
✓ Definitions/notations
✓ Metrics to rank IBs
✓ Implementation of the theory
  ▪ The software architecture
  ▪ The underlying SDB
✓ Law S-580 B
Lugeri et al. (2010): “in the near future in Europe the risk of flooding will increase.”

To limit tragic events:

A. urban planning has to take into account this increasing danger;

B. **increase** the severity of actions against IBs (discourage building in rivers’ basin).
The phenomenon of IBs

... dramatic in developing countries,
... an unsolved issue in advanced States.

Fight the IBs phenomenon:

- **punish** law’s violations;
- **protect** people's lives;
- **stop** landscape’s destruction.
DATA ABOUT ITALY

LegAmbiente’s nation-wide studies

2007:
Period covered: 1994 - 2003
Total # of IBs: 400K

2018:
Period covered: 2005 - 2018
2004: the last building amnesty
Total # of registered infringements: 57K
Protection of environment/people

Remote sensing methods

IBs DataBase

RELATED WORK (5)

demolition

the challenge of IBs
DEFINITIONS & NOTATIONS

**GeoArea:**  
<description, geometry>

\[ \mathcal{C} = \{ c_q \ (q=1, \ 2, \ \text{Card}(\mathcal{C})) \} \]
<ID, elevation, geometry>

\[ \mathcal{R} = \{ r_k \ (k=1, \ 2, \ \text{Card}(\mathcal{R})) \} \]
<ID, name, geometry>

RiverBuffer\( (r_k) \Leftrightarrow BofR \)

\[ \mathcal{B} = \{ b_i \ (i=1, \ 2, \ \text{Card}(\mathcal{B})) \} \]
<ID, geom, elevation, exp_i>
A scene depicting previous definitions
PROBLEM FORMULATION

INPUT

OUTPUT

GeoArea  C  R  B

The Ranking

<table>
<thead>
<tr>
<th>b_i</th>
<th>exp_i</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
NEXT:

- **how** to detect IBs inside the GeoArea
- **3** metrics
Census of IBs

\[
\text{INTERSECTION}((\text{geom}(b_i), \text{RiverBuffer}(r_k)) = \text{true}
\]

\[b_i: \text{ an IB}\]
Census of IBs (1)

A scene showing few IBs
Parameter $P$

\[
P = \frac{\text{Area}(\text{geom}(b_i) \cap \text{RiverBuffer}(r_k))}{\text{Area}(\text{geom}(b_i))}
\]

$P$ in $(0,1]$
Metric S1

\[ S_1 = \max \{ P_k \}, \ k = 1, 2, \ldots, n \]
Metric $S_2$

\[ S_2 = \max \left\{ \frac{P_k}{d_k} \right\}, \quad k = 1, 2, \ldots, n \]
THE RANKING:

\[ d_1 \approx d_2 \approx d_3 \]

\[ b_2: \Delta h_{b_2} < 0; \Delta h_{b_1} > 0; \Delta h_{b_3} > 0 \]

\[ b_3: \Delta h_{b_1} \ll \Delta h_{b_3} \]

\[ b_1 \]
Metric S3

\[ S_3 = \max \left\{ \frac{P_k \times H_k}{d_k} \right\} , \quad k \in [1, 2, \ldots, n] \]

\[ H_k = \begin{cases} 
|\Delta h_{b_i}| , \text{ if } \Delta h_{b_i} < 0 \\
1/\Delta h_{b_i} , \text{ if } \Delta h_{b_i} > 0.
\end{cases} \]
### IMPLEMENTATION

<table>
<thead>
<tr>
<th>Input Data Sets</th>
<th>Tables</th>
</tr>
</thead>
<tbody>
<tr>
<td>GeoArea</td>
<td>GeoArea</td>
</tr>
<tr>
<td>ContourLines</td>
<td>ContourLines</td>
</tr>
<tr>
<td>Rivers</td>
<td>Rivers</td>
</tr>
<tr>
<td>Buildings</td>
<td>Buildings</td>
</tr>
</tbody>
</table>

- **GeoArea**\((id, geom)\);
- **ContourLines**\((id, elevation, geom)\);
- **Rivers**\((id, name, geom)\);
- **Buildings**\((id, name, geom, S3)\);
LAW S 580-B (March, 2018)

**Criteria for the execution of procedures for the demolition of IBs**

<table>
<thead>
<tr>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date Crime</td>
</tr>
<tr>
<td>Realization Phase</td>
</tr>
<tr>
<td>Dangerousness for public/private Safety</td>
</tr>
<tr>
<td>Destination Usage</td>
</tr>
<tr>
<td>Environmental issues:</td>
</tr>
<tr>
<td>➢ Environmental Impact</td>
</tr>
<tr>
<td>➢ Environmental Constraints</td>
</tr>
</tbody>
</table>
THANK YOU
ADDENDUM
The speech is based on a paper you may find here:
ISPRS Int. J. Geo-Information 2019, 8, 510; doi:10.3390/ijgi8110510
Forte, Granata & Nesticò have already studied the problem of setting an order of demolition of IBs.

A Prioritisation Model Aiding for the Solution of Illegal Buildings Problem, ICCSA 2016

They were inspired by a preliminary version of Law S 580-B (March, 2018)

They proposed the application of the TOPSIS method.
TOPSIS

Technique for Order Preference by Similarity to Ideal Solution

Hwang, C.L. and Yoon, K. (1981):
New York: Springer-Verlag.

PyTOPS implements TOPSIS

Yadav et al. (2019):
PyTOPS: A Python based tool for TOPSIS.
SoftwareX, 9, 217--222 (2019)
PyTOPS’s interface

Inputs
1. Input attribute type in list form
   (e.g., 0, 1, 0; 1 is for cost type and 0 for benefit type)

2. Upload decision matrix
   (Upload decision matrix in .xlsx format as prescribed in the manual)

3. Upload weights
   (Upload weights given by user to each and every attribute in .xlsx format as prescribed in the manual)

4. Degree of variation in weights
   (0.25 means you want 25% of variation in given weights)

5. Number of simulations
   (Simulation within the given variation in weights)

Outputs

1. Rank with varying weights

2. Probability of rank reversal

3. Mean of relative closeness to ideal solution

4. Standard deviation of relative closeness to ideal solution

Save

Save

Save

Save
Indexing:
SCIE (IF 2.679);
Scopus (CiteScore 3.0)

39 Sections
EBM 2000+

11th Volume
Semi-Monthly
Released

Fast Publication
Median Time to Publication:
35 days

Monthly Full-text
views
1,200,000+

Advantages:
Fast Publication
High Visibility
Free for Readers
Low Publication Fee

Rejection Rate in
2020
59%

Website:
www.mdpi.com/journal/applsci
E-Mail: applsci@mdpi.com
Twitter: @applsci

MDPI AG
Postfach, CH-4020 Basel,
Switzerland
Special Issue:
Submission Deadline: 10 February 2022

Prof. Dr. Paolino Di Felice
University of L'Aquila,
67100 L’Aquila, Italy

Guest Editor

Topics included:
- software engineering
- UML
- MDE
- metrics for UML models
- software tools
- case studies
- empirical data
- measurements