A web-based interactive 2D and 3D GIS application to find the best place to live in a city, using open data and open source software

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What is City Focus?

- Is a web-based interactive 2D and 3D GIS application to find the best place in a city to live, or to pass shorter staying
- The user can select among different criteria and decide their importance by assigning weights to each of them
- The application provides thematic maps on the places which better fit the user’s preferences
How is City Focus different from other apps?

Most of the existing apps:


focus on finding a city to live and not on identifying a suitable place within a city.

The existing apps also allow searching for places to live by specifying few parameters such as apartment or house prices.

City focus help to perform this task in an automatic as well as user-friendly way avoiding long and hand-made search on the Web.

City Focus takes into account environmental conditions such as air quality levels, that existing apps do not consider.

The app exploits exclusively open data as well as Free and Open Source Software (FOSS) for its implementation by enabling continuous improvements while minimizing development costs.
MYGEOSS: Innovative Apps in the environmental and social domains

City Focus is a Winner of the MYGEOSS third call for innovative Apps, launched by the European Commission.

The aim: Development of innovative applications (mobile or web-based) using openly available or crowd-generated data in different domains addressing citizens’ needs.

MYGEOSS is a two-year project (2014-16) by the European Commission to develop Global Earth Observation System of Systems based smart Internet applications.

## City Focus Data

### Case Study: Milan, Italy

<table>
<thead>
<tr>
<th>Repository</th>
<th>License</th>
<th>Link</th>
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</thead>
<tbody>
<tr>
<td>Open Data Lombardia</td>
<td>Italian Open Data License v.2.0 (IODL 2.0)</td>
<td><a href="https://www.dati.lombardia.it">https://www.dati.lombardia.it</a></td>
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<td>OpenStreetMap</td>
<td>Open Data Commons Open Database License (ODbL)</td>
<td><a href="https://www.openstreetmap.org">https://www.openstreetmap.org</a></td>
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<tr>
<td>ISTAT</td>
<td>CC-BY 3.0</td>
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</tbody>
</table>
City Focus Data

Environmental conditions

- Air Quality
- Low Temperature
- Medium Temperature
- High Temperature

Near to Transportation

- Train and Metro Stations
- Bus Stops

Population Density

- Low Population Density
- Medium Population Density
- High Population Density
City Focus Data

**Near to Services**
- ATMs
- Banks
- Coffee Shops
- Hospitals
- Pharmacies
- Police Stations
- Post Offices
- Supermarkets
- Veterinary Clinics

**Near to Nature**
- Parks
- Dog Parks
- Green Areas
- Natural Water

**Landuse Type**
- Industrial or commercial units
- Continuous urban fabric
- Discontinuous urban fabric

**Near to Education**
- Universities
- High Schools
- Primary Schools
- Secondary Schools
- Kindergartens
Application principle

The output consists of a raster computed as a weighted average of the score maps representing the user’s selected criteria. The final map is then displayed with an intuitive color gradient, enabling the user to identify the best places within the city which better fits his/her preferences.

\[
r = \frac{\sum_{i=1}^{n} w_i c_i}{\sum_{i=1}^{n} w_i} \quad \{r \in \mathbb{R} \mid 0 \leq r \leq 1\}
\]
Data Processing

A. Data cleaning

1. Downloaded data
2. Reprojection
3. Projected data
4. Buffers
5. Cleaned data
B. Score maps creation

Score maps from **point layers**

- **Point layers**
- **Quartic kernel density function**
- **Spatial concentration maps**
- **Normalization**
- **Score maps**

**v.kernel, radius 1200 m**

**r.mapcalc**

**Services** (hospitals, banks, post offices, etc.)

**Education** (universities, kindergartens, primary schools, etc.)

**Transportation** (train and metro stations, bus stops) information.
Data Processing

Natural data such as parks, green areas, natural waters, etc.

Score maps from **polygon layers**

<table>
<thead>
<tr>
<th>Distance d [m] classes</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>d = 0</td>
<td>1</td>
</tr>
<tr>
<td>0 &lt; d ≤ 400</td>
<td>0.75</td>
</tr>
<tr>
<td>400 &lt; d ≤ 800</td>
<td>0.50</td>
</tr>
<tr>
<td>800 &lt; d ≤ 1200</td>
<td>0.25</td>
</tr>
<tr>
<td>d &gt; 1200</td>
<td>0</td>
</tr>
</tbody>
</table>

- Polygon layers
- Rasterization
- Raster maps
- Multiple distance buffers
- Proximity maps
- Reclassification

v.to.rast  r.buffer  r.reclass
Data Processing

Score maps from **raster layers**

- **Air Pollution**
  - Normalization*
  - Score maps
    - `r.mapcalc`

- **T°, pop, landuse layers**
  - Reclassification
    - High / Industrial
    - Medium / Continuous
    - Low / Discontinuous
    - `r.Reclass` 0 or 1 **

<table>
<thead>
<tr>
<th>Classes</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>MIN ≤ x &lt; ½*MAX</td>
<td>low</td>
</tr>
<tr>
<td>½<em>MAX ≤ x &lt; ¾</em>MAX</td>
<td>medium</td>
</tr>
<tr>
<td>¾*MAX ≤ x ≤ MAX</td>
<td>high</td>
</tr>
</tbody>
</table>

**Temperature** (high, medium, low)

**Population density** (high, medium, low)

**Landuse** (Industrial or commercial units, Continuous urban fabric, Discontinuous urban fabric)

**Air pollution** (PM2.5)
City Focus relies on a standard installation of RASDAMAN with a SQLite database backend.
Data are accessed over the web by the Petascope component of RASDAMAN, translating the incoming WCPS request into RASDAMAN rasql language queries and generating the output map.
Combining jQuery and Web WorldWind, it is possible to retrieve maps from RASDAMAN through the WPCS and show them to the end-user.
Application architecture

Criteria vector layers “locations of interest” are added into the application as geojson.

The final map, as well as the criteria raster layers “criterion map” are «painted» by coloring a grid (vector version of the score maps) using the values of the retrieved csv files from the WCPS requests.

The POST WCPS request is of the form:

```python
for a in (atms), b in (banks), c in (cafe), d in (hospitals) ... z in (discontinuous)
    return encode ( (a*50 + b*50 + c*80 + d*70 ... z*80)/180.4), "csv")
```
Conclusions

Possible improvements:

- Possibility for users to get a glimpse of the changing environment within a city through trend maps or graphs for any specific criterion (e.g. temperature changes in the last five years, etc.)

- Add the name of best scored city blocks from the final map (i.e. the cells with the highest scores) may be displayed too, associating to these cells to neighborhoods by means of geocoding.

- Take more advantage of the 3D functionalities (e.g. elevate cells according to cells values)

- Add user functionalities to gather information about user preferences, to make inferences and statistics: Useful for urban management purposes

- Add information about house/appartments sale/rent prices

As a first case study, we considered the city of Milan. In the future, other italian as well as european cities are planned to be included.
Check the application on:

http://muvias eoapps.eu/cityfocus/application.html

And the documentation /source code:

GitHub https://github.com/GabrielePrestifilippo/CityFocus

Thank you for your attention!