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Supervised classification of the French Riviera morphogenesis using a machine learning approach

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This contribution focuses on the analysis of the evolution of urban forms on the French Riviera within the 20th and early 21st centuries. More specifically, it defines evolutionary paths and contextual factors behind them. To this end, a context-specific model is created, allowing for the analysis of contextual variables and determining to what extent they influenced the evolution of urban morphology. The analysis is carried out by breaking down space into urban blocks, within the compact city, and block sections, in more dispersed suburban areas. The contextual variables represent the external morphogenetic factors of site, situation/accessibility, morphological context and historic period. Old cadastral maps and airborne images are the raw input data of our analyses. Five different study areas within the French Riviera are used to identify the evolutionary paths of urban form, to quantify them, as well as their bifurcations and the possible impacts of the external factors. Together, they are representative of the variety of observable forms on the French Riviera and of their past development paths.

In a first phase, components of the urban fabric are pre-processed. In particular, the street network undergoes in-depth processing. The linear street segment data was transformed into network coverage data and planar graphs. The study also used street continuity according to the Morpheo approach (Lagesse, 2015). The street network provides the following elements: accessibility to plots, the key element in the division of block sections and a structural element of the city's development (Hillier, 2002). Plots and buildings are also pre-processed to identify recurrent patterns in a simplified way.

In a second phase, the analysis requires supervised classification of the evolution of the form of the urban fabric. A specific label of evolutionary pathway is assigned to each spatial unit, as in previous research by the authors (Prouin et al. 2022). The expert classification is based on the classical approach of urban morphology (Conzen, 1960; Caniggia and Maffei, 1979), and knowledge of the urban history of the study area (Graff 2013). The main components of urban form are buildings, streets and plots (Marshall, 2005; Lévy, 2005), as well as the site (the orographic and hydrographic

structure of the area). To explain their evolutions, we considered both path dependency (previous morphological states and how they were achieved) and the situation of these different analysis units, namely their value in relation to their urban environment.

In a final phase, the pathways of the morphological structure becomes the target of supervised classification. The machine learning model "Support Vector Classification" is used (Maysam et al. 2012) to predict labeled categories based on non-textual data optimized for a small number of referenced individuals. The model searches for the pathway of the morphological evolution based both on the current morphological status of the spatial units and on a few explanatory variables of site and situation. Therefore, the obtained results have a dual interpretation. Firstly, the identification of the current morphological state, regardless of their morphogenesis, based on the description of the elements of urban form. Secondly, a set of metrics capable retaining the traces of the morphological pathway and capable of identifying it. The goal is to reveal residual morphological structures of a particular morphogenesis.

The analysis shows to which extent a morphological process can be inferred by observable forms and a limited number of contextual variables. By contributing to the analysis of urban forms as contingent manifestations of transitional morphologies (Trisciuglio et al. 2021), our model opens the way to assessing the evolutionary potential of present-day observable forms. The latter can thus be understood within different possible evolutionary paths, more or less plausible according to the contextual variables, and offer insight into future urban developments.

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