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Developing Automated Map Generalisation Workflow for Building, Road, and Stream Course Features in Topographic Map of Hong Kong

Chun-wan Kwok [a]

[a] *Lands Department Survey and Mapping Office, The Government of the Hong Kong Special Administrative Region of The People's Republic of China cgrcst@landsd.gov.hk*

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Abstract:
Generalisation of map features constitutes an essential process for creating maps in smaller scales. During this process, mapmakers apply appropriate generalisation operators to ensure that the map remains legible while preserving the major geographic characteristics and spatial relationships of features. Traditionally, map generalisation has been conducted manually, a time-consuming and labour intensive process that often results in lengthy revision cycle of small scale maps. This presents challenges in maintaining the currency of map content, especially in areas experiencing frequent city development. Furthermore, the subjective interventions of map makers on map generalisation hinders data quality and consistency among the maps. In light of these challenges, various National Mapping Agencies (NMAs) have recognised automated map generalization as a means to increase map production efficiency (Foerster, Stoter, & Kraak, 2010).

This paper reviews the challenges on the development of the automated map generalisation workflow for building, road, and stream course features carried out by the Survey and Mapping Office (SMO) of the Lands Department of the HKSAR Government. Hong Kong's dense urban environment and rapid infrastructure development underscore the pressing need to adopt automated map generalisation to provide timely and quality digital map data that supports smart city initiatives. The high urban density poses significant challenges to the automation of map generalisation, making the evaluation of mapping specifications, model development, and source data requirements increasingly complex. As such, SMO conducted a feasibility study on automated map generalisation in 2021. A prototype was developed which concluded that graphical generalisation was feasible, subject to the availability on the enriched source data. In March 2024, a project kicked off for the implementation of automated map generalisation workflow for 1:10,000 topographic mapping (referred as 'the Project' in this paper). The Project prioritised map features such as buildings, roads, and stream courses, which were identified as the most challenging features to be generalised automatically on the 1:10,000 topographic map. In the Project, commercial off-the-shelf (COTS) geoprocessing tools were integrated with Python customization. An Agile project management methodology was adopted, providing the solution, data enrichment, and user needs through iterative development cycles.

For building features (Figure 1), existing COTS generalisation tools often struggle to produce consistent results across diverse urban and rural representations as their density and complexity varies. While manual generalisation typically adheres to mapping specifications, human reasoning, such as analysis of urban structures and inter-theme relationships, are often subjective, which complicates the gathering and formalization of requirements necessary for developing the automated generalisation workflow (Touya, Zhang, & Lokhat, 2019). By using various Geographic Information System (GIS) operations and techniques, a customised building generalisation workflow was developed. Information such as building density and building height were analyzed and incorporated into the workflow, such that the degree of generalisation would adapt according to urban form, alongside other parameters such as building size and proximity to adjacent features.

Ensuring that the source data contains sufficient spatial and semantic variables is crucial for an effective automated map generalisation workflow. This was particularly evident in the generalisation of features such as roads and stream course features. For roads (Figure 2), we enriched the road polygon source data with road level information, which is vital to regions like Hong Kong where multiple flyover often exists. We also established linkage between road polygon and road centerline which contained detailed road segment information, enabling the generation of topologically and semantically accurate road casings and polygons at smaller scales. For stream courses (Figure 3), we enriched the 2D vector data with terrain information derived from digital elevation model (DEMs) to create a logically generalised stream course network.

To conclude, the formalization of human reasoning in map generalisation and the enrichment of source data are the keys to conducting an effective automated map generalisation workflow. While the Project is still ongoing at the time

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of this publication, and acknowledging that different NMAs have their specific challenges and requirements in the context of automated map generalisation, insights gained from the development of these features could serve as a reference for future development of automated map generalisation projects.

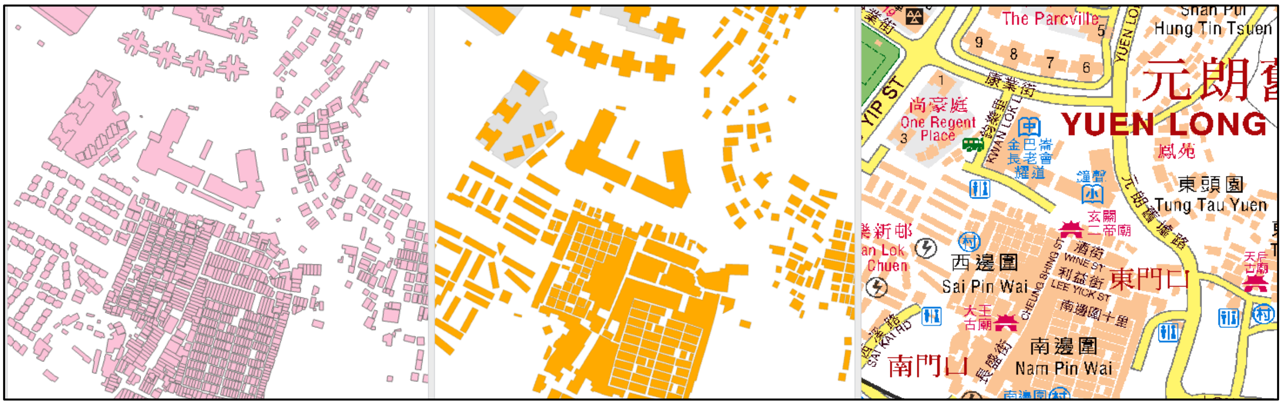

Figure 1. Building features. (*Note.* Figures from left to right: Source data (1:1,000); Output data from workflow; Current 1:10,000 map product.)

Figure 2. Road features. (*Note.* Figures from left to right: Source data (1:5,000); Output data from workflow; Current 1:10,000 map product.)

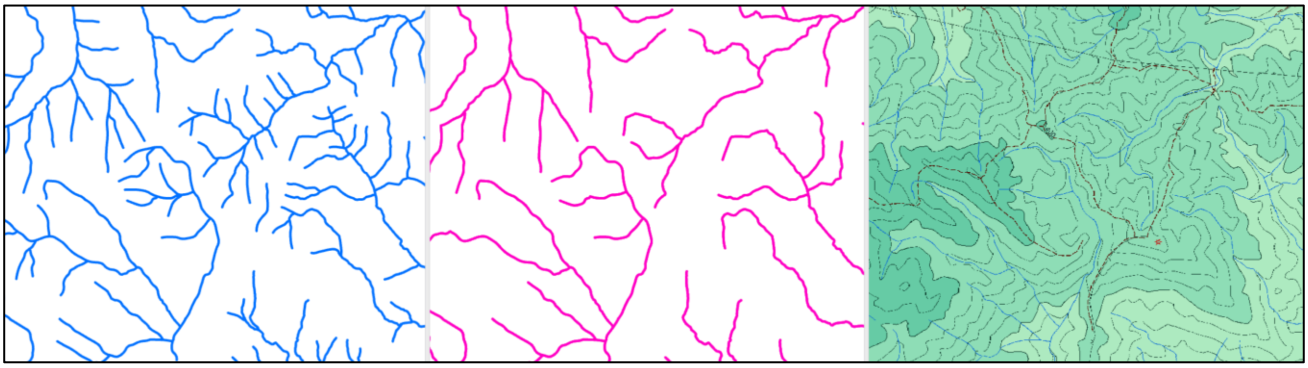

Figure 3. Stream course features. (*Note.* Figures from left to right: Source data (1:5,000); Output data from workflow; Current 1:10,000 map product.)

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