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Buildings classification from airborne LiDAR point clouds through OBIA and ontology driven approach

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In the last years, airborne Light Detection and Ranging (LiDAR) data proved to be a valuable information resource for a vast number of applications ranging from land cover mapping to individual surface feature extraction from complex urban environments. To extract information from LiDAR data, users apply prior knowledge. Unfortunately, there is no consistent initiative for structuring this knowledge into data models that can be shared and reused across different applications and domains. The absence of such models poses great challenges to data interpretation, data fusion and integration as well as information transferability. The intention of this work is to describe the design, development and deployment of an ontology-based system to classify buildings from airborne LiDAR data. The novelty of this approach consists of the development of a domain ontology that specifies explicitly the knowledge used to extract features from airborne LiDAR data. The overall goal of this approach is to investigate the possibility for classification of features of interest from LiDAR data by means of domain ontology. The proposed workflow is applied to the building extraction process for the region of "Biberach an der Riss" in South Germany. Strip-adjusted and georeferenced airborne LiDAR data is processed based on geometrical and radiometric signatures stored within the point cloud. Region-growing segmentation algorithms are applied and segmented regions are exported to the GeoJSON format. Subsequently, the data is imported into the ontology-based reasoning process used to automatically classify exported features of interest. Based on the ontology it becomes possible to define domain concepts, associated properties and relations. As a consequence, the resulting specific body of knowledge restricts possible interpretation variants. Moreover, ontologies are machinable and thus it is possible to run reasoning on top of them. Available reasoners (FACT++, JESS, Pellet) are used to check the consistency of the developed ontologies, and logical reasoning is performed to infer implicit relations between defined concepts. The ontology for the definition of building is specified using the Ontology Web Language (OWL). It is the most widely used ontology language that is based on Description Logics (DL). DL allows the description of internal properties of modelled concepts (roof typology, shape, area, height etc.) and relationships between objects (IS_A, MEMBER_OF/INSTANCE_OF). It captures terminological knowledge (TBox) as well as assertional knowledge (ABox) - that represents facts about concept instances, i.e. the buildings in airborne LiDAR data. To assess the classification accuracy, ground truth data generated by visual interpretation and calculated classification results in terms of precision and recall are used. The advantages of this approach are: (i) flexibility, (ii) transferability, and (iii) extendibility - i.e. ontology can be extended with further concepts, data properties and object properties.