A World of Models

Model-based object recognition is a beautiful concept. From sensory input data such as imagery and laser point clouds, features are extracted, grouped and organised into constructs that may correspond to objects, at least partially. The â€˜maybeâ€™ question is answered by reasoning processes that compare the constructs with a library of object models. Since such object models are common in GIS, it would be appealing to populate them with objects following the model-based object recognition paradigm. Obviously, success hinges on the similarity between the constructs obtained from the data and the models of objects. The following comments elucidate the difficulty of narrowing the gap between data models and object models.

Mental World

Let us explore the world of models and their intricate relationship by beginning with the physical world: a world consisting of atoms, molecules, particles, electromagnetic fields and much empty space. The world we experience as human beings is rather different however. Our world consists of objects, smell, tastes, tones and colour. It is a mental world constructed from our senses that react to signals and evoke sensations perceived as sound, smell, or an â€˜imageâ€™. Although we do not have access to each otherâ€™s mental reconstructions, we all see the world quite similarly, as may be concluded from how we respond to the environment. Considering that the signals we receive are ambiguous, distorted, incomplete and noisy, it is most remarkable that we arrive at a consistent and stable reconstructed world.

Object Description

Let us revisit the object models needed in model-based object recognition for a moment and ask the question how to construct them. I assert that we derive these models by way of abstraction from our mentally reconstructed (perceived) world. And that is the crux: how do you describe an object? Suppose your friend never saw an opossum. How do you describe to her in concise and general terms an opossum so that she will recognise it, regardless of age, gender, and environment and distinguish it from a big, fat rat?

Assuming that we succeed in developing suitable models, object recognition will result in the reconstructed world, which is not yet the GIS world, however. For one, there may be missing information that comes from other sources than the sensors. Moreover, the level of abstraction is likely to be higher. For example, certain details of a reconstructed object may be left out and the boundaries of objects do not precisely follow the physical boundaries as they are straight, parallel, perpendicular, and so on. We realise that the degree of abstraction and generalisation of GIS objects poses an additional challenge.

Further progress in object recognition can be achieved by narrowing the gap between data models and object models. A closer collaboration between GIS modellers and object-recognition modellers would appear to be beneficial. Conceptually, GIS models can be perceived as constructors in an object-oriented programming language. The instantiation of objects would then take place during the hypotheses-verification cycle of the reasoning process.