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# Modification of pedo-transfer functions using KSL model

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## ABSTRACT

In recent years, fuzzy modeling technique has been successfully employed to model complex systems, where classical methods e.g. mathematical and model-free methods are inapplicabe due to the lack of sufficient information. Generally model free-methods such as neural networks are prefered when a significant amount of data exists as they provide more robust means to identify and reproduce the existing patterns in the available data. However, when limited amount of data exist but ambiguous or imprecise information are available, fuzzy reasoning provides a way to understand system behavior. Before Bouma (1989) introduced the term pedo-transfer functions (PTFs), described as translating data we have into what we need, some hydraulic properties' PTFs had been developed in modeling water movement and solute transport in soil due to the increasing of computational speed and expanding of models' complexity (Gupta and Larson, 1979). Many studies related to modeling various soil parameters using different types of PTFs has been conducted (Schaap et al., 1998; McBratney et al., 2002; Vos et al., 2005).

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# Introduction

In this study, a new conceptual model for pedo-transfer functions is developed and proposed as a modification of standard fuzzy modeling method based on the table look-up scheme which we called Keshavarzi-Sarmadian-Labbafi (KSL) model.

In KSL fuzzy model, there are five steps in generating fuzzy rules with fixed membership functions. Step 1) Define the fuzzy partition of the input and output variables. Step 2) Generate one fuzzy rule for each of the n input-output pairs.

From this input-output pair, one fuzzy rule can be generated. One may be reminded of the facts that the fuzzy sets may overlap. Now the question is how to assign the appropriate membership functions to variables in each data pair. The fuzzy variable is assigned the membership function that produces the maximum membership value. Step 3) Calculate the degree for each fuzzy rule resulted from rules. The number of fuzzy rules generated by the input-output pairs is usually large. Inconsistent and redundant rules are inevitable. One is then confronted with the task of elimination of the inconsistency and redundancy.

Step 4) Create the final fuzzy rule-base by removing inconsistent and redundant rules. As an improvement, the concept of reliability factor is introduced (Keshavarzi et al., 2011a).

The reliability factor is then used as a weighting factor for computing the effective degree for each rule degree. The final fuzzy rule-base can now be compiled by choosing the rules with the largest effective degrees.

Step 5) Determine the overall fuzzy system. Up to this point, the membership functions are defined in step 1 and the fuzzy rule-base is compiled in step 4. To generate fuzzy inference system, Mamdani's inference system is adopted for its simplicity. Any T-norm or S-norm can be used to define the operations involving membership function. In addition, any defuzzification scheme such as the centroid method can be selected (Keshavarzi et al., 2011b). This essentially completes the design procedure in modeling a fuzzy system.

In summary, the modified table look-up scheme offers an effective method for removing inconsistency and redundancy in the process of assembling fuzzy rules for developing pedotransfer functions.

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