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BAYESIAN APPROACH ON PARAMETER ESTIMATION IN HIDDEN MARKOV MODEL

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ABSTRACT

This paper presents study about the parameter estimation in hidden markov model. The approach is taken from a Bayesian method, there will be two sources of information,there are information from the likelihood function and the prior function. This approach will be applied to daily rainfall data in Darajat, Garut. The numbers of hidden states are used in this paper based on Schmidth and Fergusson's climate classification which are suitable to the local conditions. This classification was obtained three types of division in the period of one year where the condition called wet months when monthly rainfall > 100 mm per month, moist months when monthly rainfall between 100 - 60 mm and the dry months when monthly rainfall <60 mm per month. The process estimation of hidden markov parameters is using Gibbs Sampler algorithm.

Keywords: hidden Markov models, Bayesian, Schmidth and Fergusson's Climate classification, Gibbs sampler.

INTRODUCTION

Modeling of the precipitation has been developed by many researchers; one of them is Coe and Stern (1982) who tried to modeling the daily rainfall data in Zinder region, Nigeria and the Kharja, Jordan. The method used at their research was Generalized Linear Models (GLM) and markov chain. In the 1970's the mathematician Baum and Petrie introduced markov chain development, namely Hidden Markov Model (HMM). HMM was increasingly popular applied in various fields? Rabiner (1989) applied the methods of HMM in speech recognition. Zucchini and Guttorp (1991) applied HMM in the precipitation phenomena. In their research, Zucchini and Guttorp introduced unobserved climate states that influence the occurrence of rain. Thyer and Kuezera (2000) developed a method of HMM to simulate the long-term hydroclimatic data for water resource planning in Australia.

In previous studies, the number of hidden states was observed only two kinds, while in Indonesia itself more widely used climate classification based on Schmidth and Fergusson. In Sudrajat's research (2009) mentioned that according Schmidth and Fergusson (1951), classification of climate is based on a comparison between the dry and wet months, from this relationship was obtained three types of division in the period of one year where the condition called wet months when monthly rainfall > 100 mm per month, moist months when monthly rainfall between 100 - 60 mm and the dry months when monthly rainfall <60 mm per month.

Garut's topographic itself is the mountains area where there are protected forests and plantations. The climate clasification which are suitable for this area is climate classification based on Schmidth and Fergusson (Sudrajat, 2009).

The process of parameter estimation in hidden markov models in several previous studies were based on a frequentist approach using Baum-Welch algorithm or EM Algorithm. At this approach, the parameters only considered as a fixed value. However, there are other approaches that assume these parameters will form a random variable. It can be happened, because the parameters of hidden markov models, particular in the case of hydrology (rainfall), the influence of time would make the values of these parameters to form a random variable having a probability distribution. So the Bayesian approach can be used in the process of parameter estimation in hidden markov model. So in this paper want to study about parameter estimation in hidden markov models with three different types of hidden climate states in Garut through a Bayesian approach.

HIDDEN MARKOV MODEL (HMM) WITH THREE HIDDEN CLIMATE STATES

Basic Model of HMM

HMM are models in which the distribution that generates an observations depends on the state of an underlying and unobserved markov process (Zucchini and MacDonald, 2009).

The basic model of HMM was illustrated by Ingmar Visser (2011) as shown below:

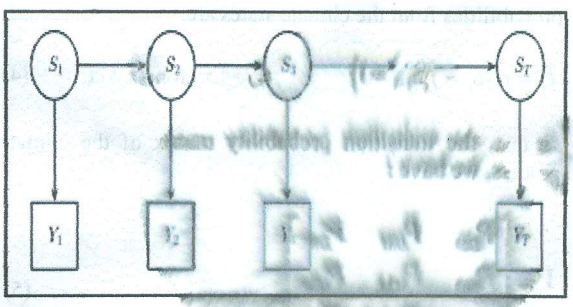

Figure-1. Hidden Markov Model Illustrated.