Research project report

Bastien Nony, Alban Gossard
Institut National des Sciences Appliquées,
Toulouse,
nony@etud.insa-toulouse.fr
gossard@etud.insa-toulouse.fr

March 12, 2018

Abstract

In this work we study surrogates problems for different types of modelling problem. The objective is to provide fast calculation for undetermined values. Beginning from physical equations such as Saint-Venant's, we add statistical formulas to determine the variability of the system. This study registers in the frame of geostatistics.

Contents

1 Objectives

2 Key notions

3 Study of 1D model

3.1 Presentation

3.2 Theoretical tools

3.3 Surrogate model analysis

3.3.1 First example : Ishigami

3.3.2 Garonne Model

Surrogate method : kriging

We compute different surrogate using different initial sample size. These surrogates were computed using a least square strategy. Figure 1 gives the simulations results for the surrogate. One can observe that we obtain almost the same resultats as the initial sample size is greater than 10. As we will explain in part **??**, the results are quite precise but we have no information about the standard

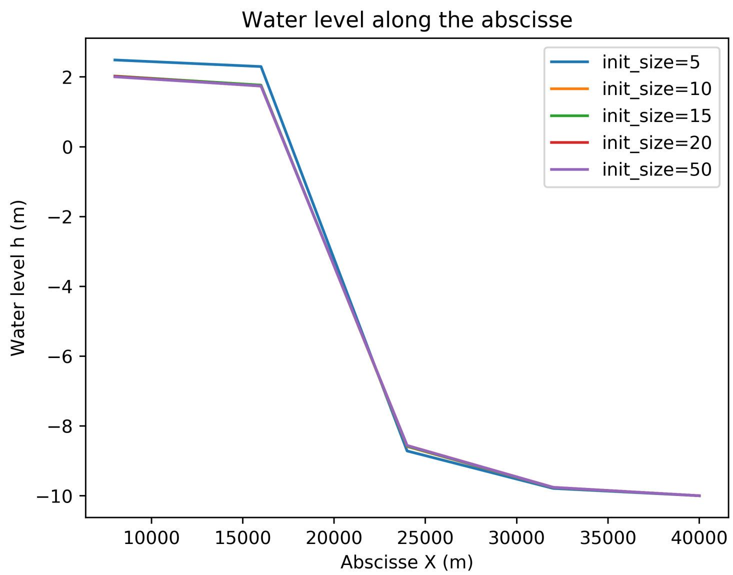

Figure 1: Water level along the abscisse for simulations with different initial sample size using kriging method for surrogate computing.

deviation of this new model and its sensibility to the parameters. Computing a surrogate with a greater number of points is fundamental to get a quantification of the error.

Surrogate method : pc

Figure 2 shows water level along the abscisse for simulations using pc method for surrogate computing with different initial sample size. We can see that using a sample with a size greater than 20 is useless regarding the surrogate predictions.

Figure 3 shows water level along the abscisse varying maximum pc degree. One can see that a degree of 3 is enough to be accurate on predictions. This mean that we do not a high pc degree to reconstitue data.

Q2 study

Distributions

One can consider that the D_{ref} distribution is a good approximation of real Q and K_s values, meaning that we can compare different distributions with an

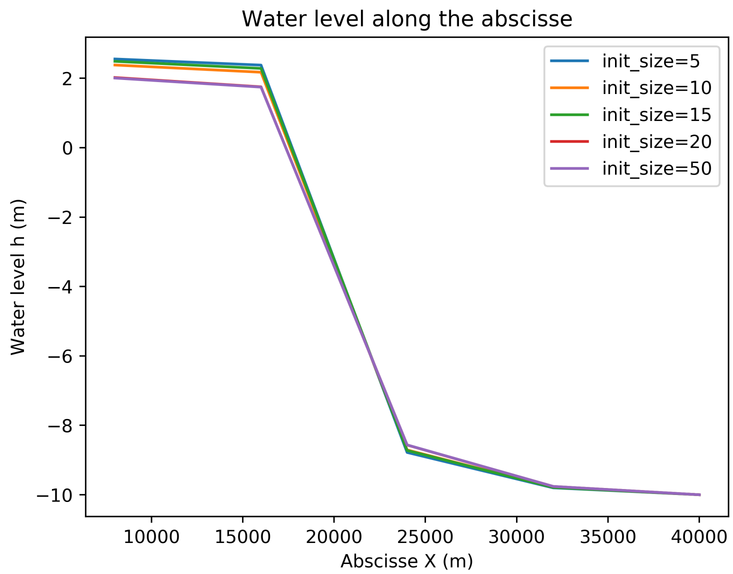

Figure 2: Water level along the abscisse for simulations with different initial sample size using pc method for surrogate computing.

Max pc degree	Q2 value
1	0.77805266
2	0.95102133
3	0.99238156
4	0.99782457
5	0.99813309

Table 1: Q2 value for different maximum pc degree using pc method for surrogate computing.

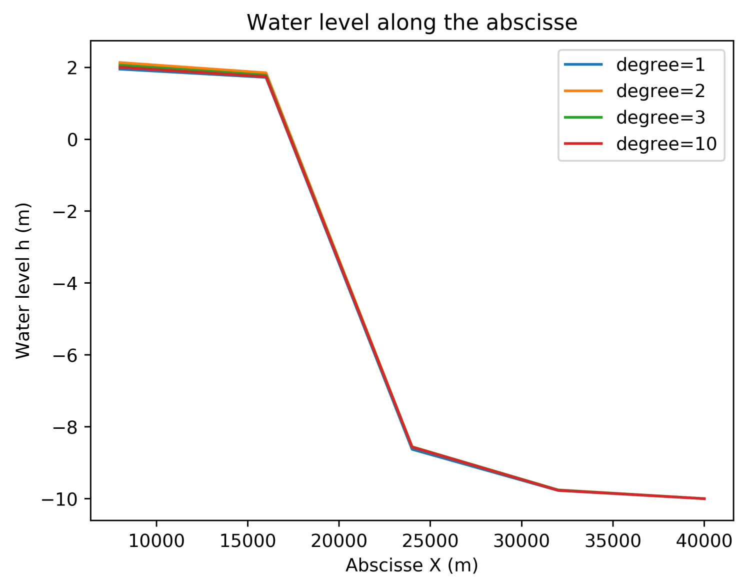

Figure 3: Water level along the abscisse for simulations with different maximum pc degree.

initial sample size smaller than D_{ref} one (which is computed with a high initial sample size, e.g. 20). Figure 4 gives water level along abscisse for different sampling distributions on Q and K_s. The distribution D_1 is the closest one to D_{ref} suggesting we should sample the space (Q, K_s) using a uniform distribution on K_s and a normal one on Q.

3.3.3 Michalewicz example

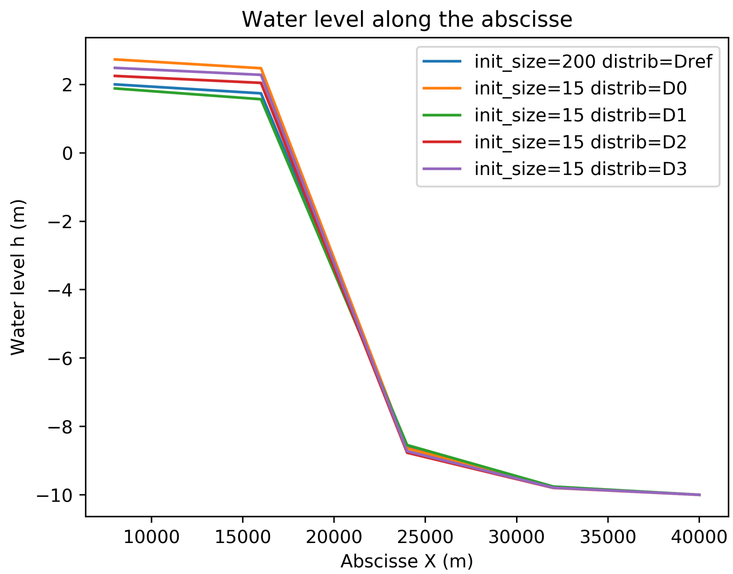

Figure 4: Water level along the abscisse for simulations with different distributions for Q and K_s using least square strategy for surrogate computing. Distributions are the following :

- D_{ref} : $K_s \sim BetaMuSigma(37.5, 5, 15, 60)$, $Q \sim BetaMuSigma(4035, 400, 2500, 6000)$
- D_0 : $K_s \sim Uniform(15, 60)$, $Q \sim Uniform(2500, 6000)$
- D_1 : $K_s \sim Uniform(15, 60)$, $Q \sim BetaMuSigma(4035, 400, 2500, 6000)$
- D_2 : $K_s \sim BetaMuSigma(37.5, 5, 15, 60)$, $Q \sim Uniform(2500, 6000.)$
- D_3 : $K_s \sim BetaMuSigma(37.5, 5, 15, 60)$, $Q \sim BetaMuSigma(4035, 400, 2500, 6000)$