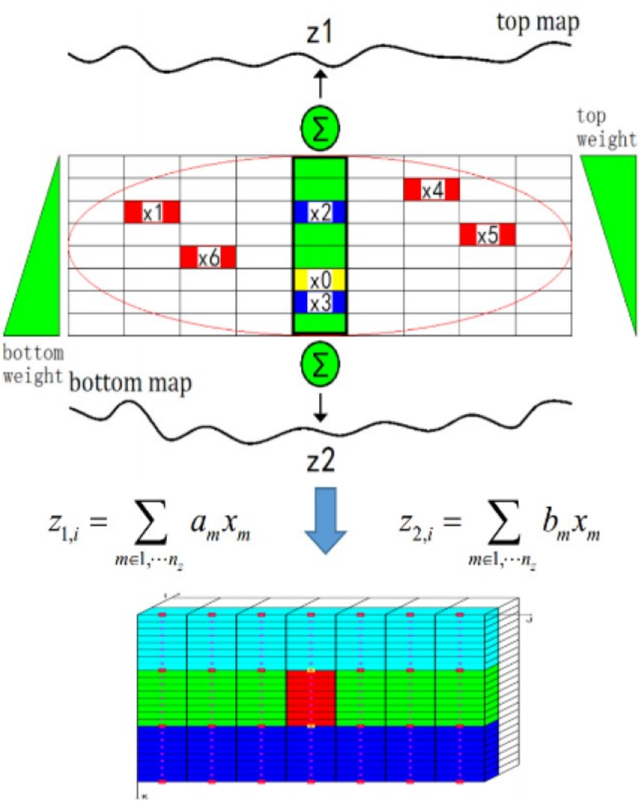
A simple guide to understanding multi-attribute Bayesian SGS method

Bayesian posterior distribution

$$P(X \mid \mathrm{Y}) = \frac{P(X)P(Y \mid X)}{P(\mathrm{Y})} = \frac{P(X)P(Y \mid X)}{\int P(\mathrm{Y})P(Y \mid X)dX} \infty P(X)P(Y \mid X)$$



Multi-attribute Bayesian Sequential Gaussian Simulation for utilization of seismic cube as the conditional data

Posterior distribution conditioned to seismic attributes：

$$p(x_0 \mid x_{s)}, z_1, z_2) \infty p(x_0 \mid x_{s)}) f(z_1 \mid x_{s)}, x_0) g(z_2 \mid x_{s)}, x_0, z_1)$$

If the conditional distributions of the reservoir properties in the z_1， z_2 cells are only influenced by the cells in the same column：

$$f(z_1 \mid x_s, x_0) \approx f(z_1 \mid x_c, x_{0)}) = f(z_1 \mid x_{c+0})$$

$$g(z_2 \mid x_{s)}, x_0, z_1) \approx g(z_2 \mid x_c, x_{0)}, z_1) = g(z_2 \mid x_{c+0}, z_1)$$

As the result:

$$p(x_0 \mid x_{s)}, z_1, z_2) \propto \boxed{p(x_0 \mid x_{s)}) f(z_1 \mid x_{c+0}) g(z_2 \mid x_{c+0}, z_1)}$$

Gaussian assumption

$$N(m_o, \sigma_0^2) \propto N(m_{SK}, \sigma_{SK}^2) N(m_f, \sigma_f^2) N(m_g, \sigma_g^2)$$

$$m_f = \sum_{j \in c+0} (\lambda_j^{'} + a_j) \; \mathrm{x}_j$$

$$\sigma_f^2 = -\sum_{i \in c+0} \sum_{j \in c+0} (\lambda_i^{'} \, a_j \, \mathrm{c}_{ij}) + \sum_{i \in c+0} \sum_{j \in c+0} (a_i \, a_j \, \mathrm{c}_{ij})$$

$$m_g = \sum_{j \in c+0} (\mu_j^{'} + b_j) \; \mathrm{x}_j + \mu_{z_1} \; z_1$$

$$\sigma_g^2 = -\sum_{i \in c+0} \sum_{j \notin c+0} (\mu_i^{'} \, b_j \, \mathrm{c}_{ij}) - \mu_{z1} \sum_{i \notin c+0} \sum_{j \in 1, \dots, n,} (b_i \, a_j \, \mathrm{c}_{ij}) + \sum_{j \notin c+0} \sum_{j \notin c+0} (b_i \, b_j \, \mathrm{c}_{ij})$$

$$m_0 = \left\{ \sigma_f^2 \sigma_g^2 m_{SK} + \sigma_{SK}^2 \sigma_g^2 (\lambda_0^{'} + a_0) \left[z_1 - \sum_{j \in c} (\lambda_j^{'} + a_j) x_j \right] + \sigma_{SK}^2 \sigma_f^2 (\mu_0^{'} + b_0) \left[z_2 - \sum_{j \in c} (\lambda_j^{'} + b_j) x_j - \mu_{z_1} z_1 \right] \right\} / d$$

$$\sigma_0 = \sigma_{SK}^2 \sigma_f^2 \sigma_g^2 / d \qquad d = \sigma_f^2 \sigma_g^2 + \sigma_{SK}^2 \sigma_g^2 (\lambda_0^{'} + a_0)^2 + \sigma_{SK}^2 \sigma_f^2 (\mu_0^{'} + b_0)^2$$