地震マグニチュードの予測モデル

基準モデル：Gutenberg-Richter 則 （b＝定数 ~ 0.9）

$$GR(M) = 10^{a-b(M-M_c)}$$

Gutenberg-Richter 則 （b＝位置依存, Ogata, 2011 *EPS*）

$$GR(M \mid x, y) = 10^{a(x,y)-b(x,y)(M-M_c)}$$

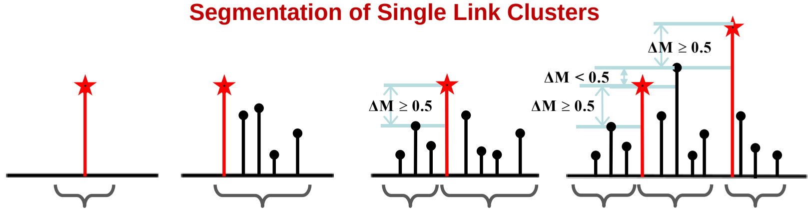
履歴に依存するマグニチュード分布

$$\Gamma(M \mid H_t)\,dM = P\left(M < Magnitude \le M + dM \mid H_t\right)$$

但し.

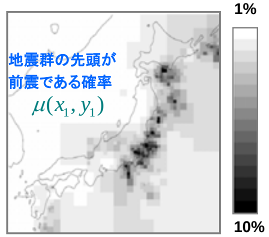
$$H_t = \left\{ (t_j, x_j, y_j, M_j);\ t_j < t \right\}$$

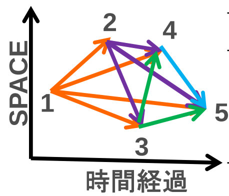
Segmentation of Single Link Clusters



$p_{c|n}$ ＝ 地震群 c の n 番目の地震でマグニチュードが0.5以上の更新確率

$$\ln\frac{1-p_{c|n}}{p_{c|n}} = \ln\frac{1-\mu(x_1,y_1)}{\mu(x_1,y_1)} + \frac{1}{\#\{i<j\}}\sum_{i<j<n}\left[a_1 + \sum_{k=1}^{3} b_k \gamma_{i,j}{}^k + \sum_{k=1}^{3} c_k \rho_{i,j}{}^k + \sum_{k=1}^{3} d_k \tau_{i,j}{}^k\right]$$





係数 from Ogata, Utsu and Katsura, 1996, *GJI*

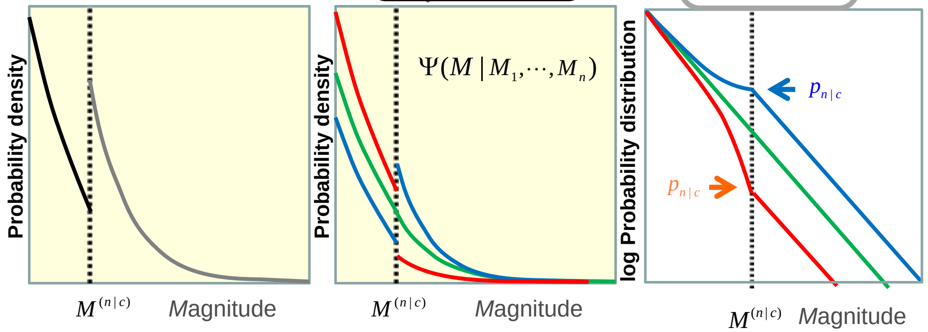
k	a_k	b_k	c_k	d_k
1	8.018	−33.25	−1.490	−10.92
2		62.77	2.805	295.09
3		−37.66	−2.190	−1161.50

Magnitude Gap : $M^{(n|c)} = \max\{M_k;\ k = 1, \cdots, n \mid \text{in cluster } c\} + 0.5$

Probability of M≧Mmax+0.5 of the next magnitude; $p_{n|c} = P\{M_{n+1} > M^{(n|c)} \mid in\ c\}$

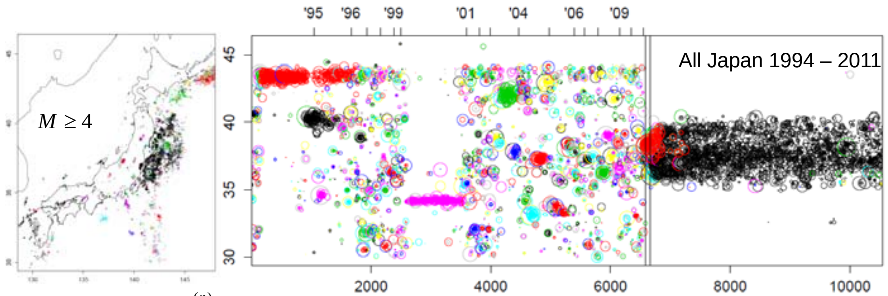
If $(t_{n+1}, x_{n+1}, y_{n+1})$ is connected to c,

$$\Psi(M \mid M_1, \cdots, M_n) = (1 - p_{n|c})\frac{1_{(M_c, M^{(n|c)})}(M)\cdot 10^{-bM}}{\int_{M_c}^{M^{(n|c)}} 10^{-bM}\,dM} + p_{n|c}(M)\frac{1_{(M^{(n|c)},\,\infty)}\cdot 10^{-bM}}{\int_{M^{(n|c)}}^{\infty} 10^{-bM}\,dM}$$

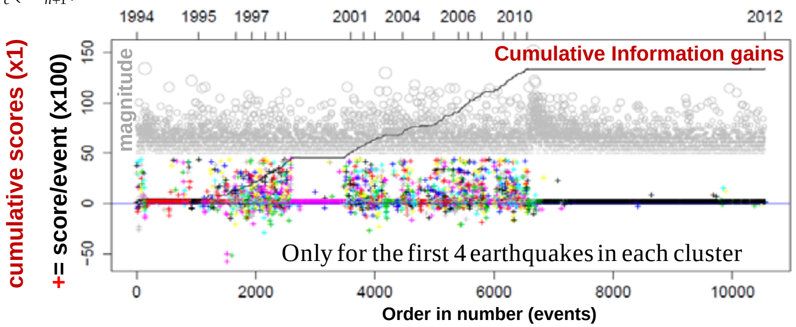


Otherwise, the reference model $\Psi(M) = 1_{(M_c,\infty)}(M)\cdot 10^{-bM} \Big/ \int_{M_c}^{\infty} 10^{-bM}\,dM$

log likelihood-ratio = information gain: $\log L/L_0 = \sum_{c}\sum_{n=1}^{\#c} \log\frac{\Psi_c(M_{n+1} \mid M_c^{(n)})}{\Psi_c(M_{n+1})}$



$\log\frac{\Psi_c(M_{n+1} \mid M_c^{(n)})}{\Psi_c(M_{n+1})}$ **= Information gain score per earthquake (+ signs)**



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