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Double-Difference adjoint seismic tomography

Yanhua O. Yuan 2016 文章 GJI

$\gamma_i(\tau) = \int_0^T s_i(t+\tau) d_i(t)\, dt$ 互相关序列

$\Delta t_i = \arg\max_\tau \gamma_i(\tau)$ γ_i的最大值时的τ取值即为Δt_i

$\Delta t_{ij}^{syn} = \arg\max_\tau \Gamma_{ij}$, s_i和s_j量

Δt_{ij}^{obs} , d_i和d_j量.

$\Rightarrow \Delta\Delta t_{ij} = \Delta t_{ij}^{syn} - \Delta t_{ij}^{obs}$

misfit function:

$\chi_{cc}^{dd} = \frac{1}{2}\sum\sum[\Delta\Delta t_{ij}]^2$ 注意:!! 最终目标仅仅是到时差拟合好!

$\delta\chi_{cc}^{dd} = \sum_i\sum_{j>i}[\Delta\Delta t_{ij}]\,\delta\Delta t_{ij}^{syn}$ 用cc算出来.

直接拟合整个cc曲线! 我可考虑

扰动后cs:

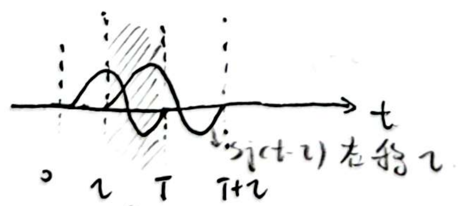
$\tilde{\Gamma}_{ij} = \Gamma_{ij} + \delta\Gamma_{ij} = \int s_i(t+\tau) s_j + \delta\int s_i(t+\tau) s_j$

$= \int s_i(t+\tau) s_j + \int \delta s_i(t+\tau)\, s_j + \int s_i(t+\tau)\,\delta s_j$

下面探讨互相关积分区间上下限问题

$\int_0^T \delta s_i(t+\tau) s_j = \int_{-\tau}^{T+\tau} \delta s_i\, s_j(t-\tau)\, dt = \int_\tau^T + \underbrace{\int_T^{T+\tau}}_{为0} = \int_\tau^T = \int_0^T - \underbrace{\int_0^\tau}_{为0} = \int_0^T$

左图



=

只有中间 $s_j(t-\tau)$和$s_i(t)$都不为0, 因为[0,T]以外的点补0了.(在互相关时)

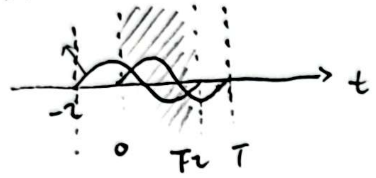
则 $\int_\tau^{T+\tau} \delta s_i\, s_j(t-\tau)\, dt = \int_\tau^T \delta s_i\, s_j(t-\tau)\, dt$, 由于$\int_0^\tau$也为0.

则加上也可 $\int_\tau^T + \int_0^\tau = \int_0^T$

同理:

对 $\int_0^T \delta s_i(t+\tau)\, s_j$:

s_i 左移 τ



只有中间 $\int_0^{T-\tau}$ 不为0.

~~$\delta(f\cdot g) = \delta f\cdot g + \delta g\cdot f$ 只有 $\delta\to 0$ 时成立. 微分. 在离散世界~~

~~exactly:~~

~~$\delta fg = \delta f\, g + \delta g\, f \pm \delta g\,\delta f$~~

求 $\tilde{T}_{ij} = T_{ij} + \delta T_{ij}$ 的 δT_{ij} 用到了

$\delta(f\cdot g) = \delta f\cdot g + \delta g\cdot f$ 全微分. 但全微分是 $\delta\to 0$ 时数学上成立的.

exactly:

$$\delta(fg) = (f+\delta f)(g+\delta g) - fg$$

$$= \delta f\cdot g + \delta g\cdot f + \underline{\delta g\,\delta f}$$

数学上可省. 但是在离散世界不定.

文章核心:

目标不是每个台观测和各自的正演对上.

而是台台间的走时差 和 正演波形量的台台走时差对上.

(通过 CC 算出)