Observations Only

$u = 0$

$c = r$

NL: $F(\hat{l}) = 0$

L: $Av = f$

$A = \partial F / \partial l$

$f = -F(l^\circ) - A(l - l^\circ)$

$Q = W^{-1}$

$Q_e = AQA^T$

$W_e = Q_e^{-1}$

$k = W_e f$

$v = QA^T k$

update $l^\circ_{new} = l + v$

compute $\Delta l = l^\circ_{new} - l^\circ_{old}$

re-evaluate A, f

test convergence Δl small or Φ stable

iteration loop

General Least Squares or Mixed Model

$0 < u < n_0$

$c = r + u$

NL: $F(\hat{l}, x) = 0$

L: $Av + B\Delta = f$

$A = \partial F / \partial l$

$B = \partial F / \partial x$

$f = -F(l^\circ, x^\circ) - A(l - l^\circ)$

$Q = W^{-1}$

$Q_e = AQA^T$

$W_e = Q_e^{-1}$

$\Delta = (B^T W_e B)^{-1} B^T W_e f$

$k = W_e(f - B\Delta)$

$v = QA^T k$

update $x^\circ_{new} = x^\circ + \Delta$

update $l^\circ_{new} = l + v$

compute $\Delta l = l^\circ_{new} - l^\circ_{old}$

re-evaluate A, B, f

test convergence $\Delta, \Delta l$ small or Φ stable

iteration loop

Indirect Observations

$u = n_0$

$c = n$

NL: $F(\hat{l}, x) = \hat{l} - G(x) = 0$

L: $v + B\Delta = f$

$B = \partial F / \partial x$

$f = -F(l, x^\circ)$

$\Delta = (B^T W B)^{-1} B^T W f$

$v = f - B\Delta$

update $x^\circ_{new} = x^\circ + \Delta$

re-evaluate B, f

test convergence Δ small or Φ stable

iteration loop

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initial $l^\circ = l$
so initial $l - l^\circ = 0$

If linear just do once through loop
f: "misclosure vector" should be small

$\Phi = V^T W V$

$w_i = \dfrac{\sigma_0^2}{\sigma_i^2}$

Choose σ_0^2 to be typical σ^2, or 1, or anything

Least Squares Estimation (left out Error Propagation!)