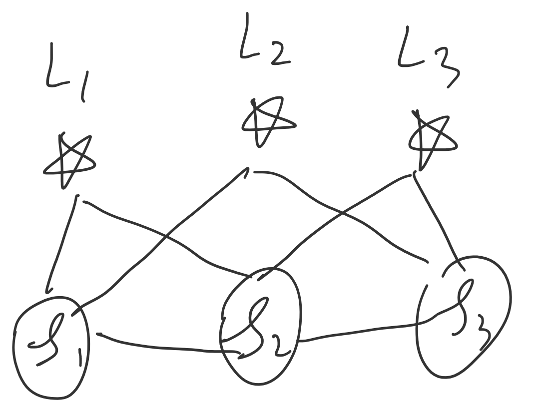
VIO from scratch 6-2

Tuesday, April 7, 2020 11:46 AM

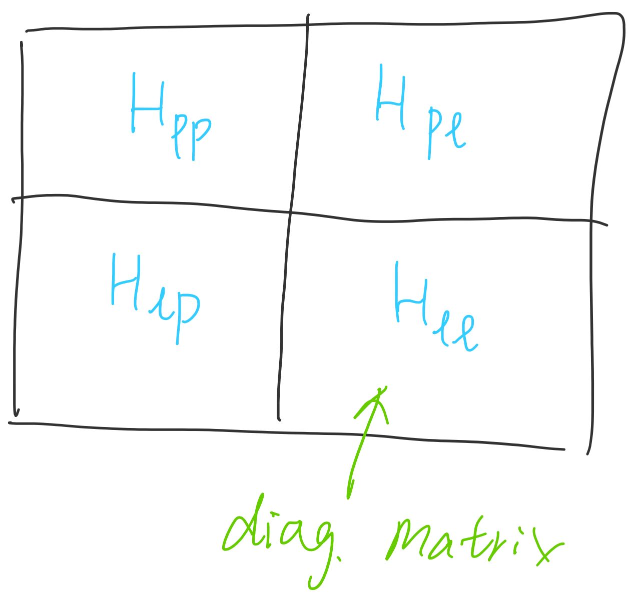
$\xi = \arg\min_{\xi} \frac{1}{2} \sum_i \| r_i \|^2_{\Sigma_i}$



normal eq. $\underbrace{J^T \Sigma^{-1} J}_{H \text{ or } \Lambda} \delta \xi = \underbrace{-J^T \Sigma^{-1} r}_{b}$

$\sum_{i=1}^{n} J_i^T \Sigma_i^{-1} J_i \delta\xi = -\sum_{i=1}^{n} J^T \Sigma_i^{-1} r$

$\Delta x = -H^{-1} b$ has large computation cost. We should use the sparse matrix and use Schur Complement:



$$\begin{bmatrix} H_{pp} & H_{pl} \\ H_{lp} & H_{ll} \end{bmatrix} \begin{bmatrix} \Delta x_p^* \\ \Delta x_l^* \end{bmatrix} = \begin{bmatrix} -b_p \\ -b_l \end{bmatrix}$$

$$(H_{pp} - H_{pl} H_{ll}^{-1} H_{pl}^T) \Delta x_p^* = -b_p + H_{pl} H_{ll}^{-1} b_l$$

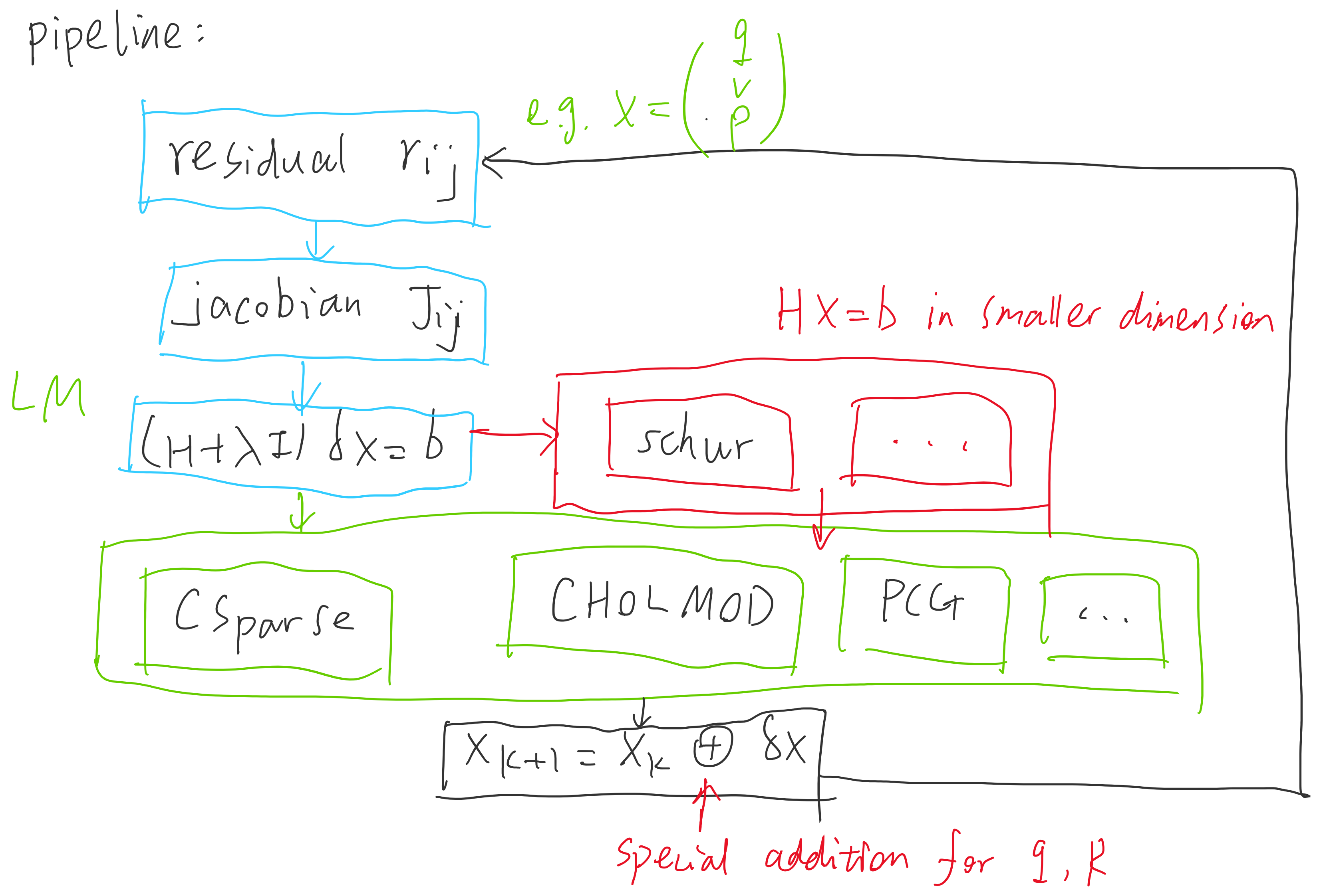
Solve for Δx_p^*, then Δx_l^* is:

$$H_{ll} \Delta x_l^* = -b_l - H_{pl}^T \Delta x_p^*$$

i.e.

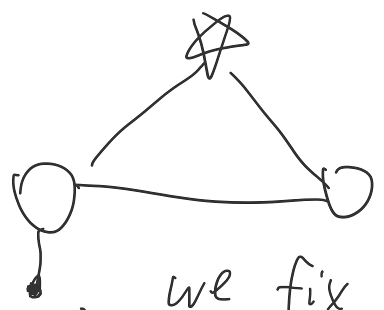
$p(a,b) \rightarrow p(a)$ or $p(b)$

Solver pipeline:



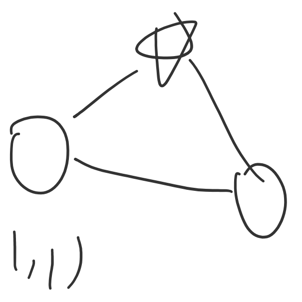
issues:

When using LM, we use $H + \lambda I$ to make H full rank, but the solution may change in nullspace:



(0,0,0) we fix first pose to origin

but after LM, we may get



(1,1,1)

the first pose is drifted from (0,0,0) to min. the cost.

To solve this, we may add a prior to first pose, by adding a residual of first pose wrt $\begin{bmatrix} I & 0 \\ 0 & 1 \end{bmatrix}$.

We can fix two camera poses to also fix the scale.

Alternatively, in G2O, add I to first pose's info. matrix.

$$\begin{bmatrix} H_{11} & & \\ & H_{12} & \\ & & \ddots \end{bmatrix} x = b + v \Rightarrow \begin{bmatrix} H_{11} + I & & \\ & H_{12} & \\ & & \ddots \end{bmatrix} x = b + v$$

this is to say $I x_1 = 0$, $x_1 = 0$.

Also we can add large info. matrix 10^{15}, to make $\delta x = 0$.

Also, we can set the jacobian to 0, then residual is 0.

$$(0 + \lambda I)\delta x = 0 \Rightarrow \delta x = 0$$

G2O:

Vertex $\begin{cases} \text{id, dimension, matrix index} \\ \text{addition: e.g. } R = R\exp(\xi_x) \end{cases}$

edge $\begin{cases} \text{residual} \\ \text{jacobian} \\ \text{vertices} \end{cases}$

solver $\begin{cases} \text{LM} \\ H, b \\ \text{QR, SVD, PCG} \cdots \end{cases}$