

APPENDIX

因子分解の計量拘束

Computation Flow of Metric Constraints

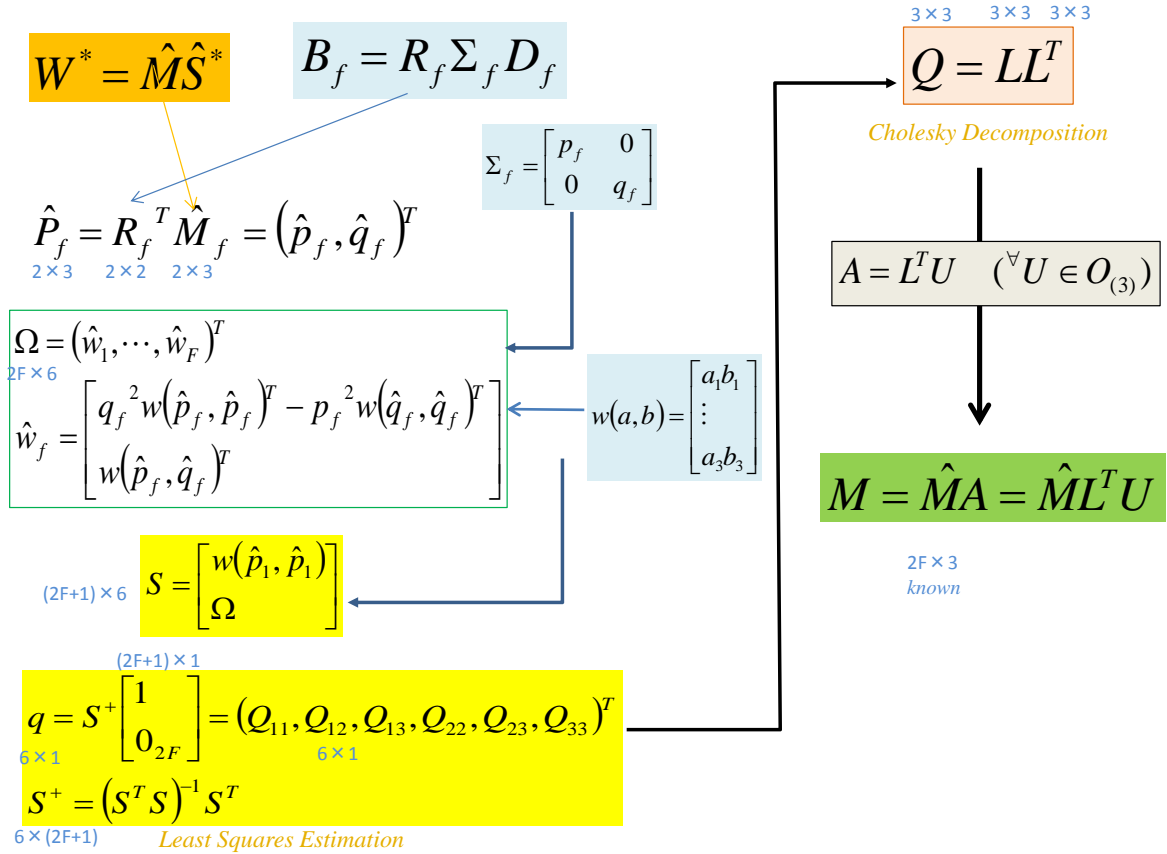


図 A.1 計量拘束のフロー
 Fig. A.1. Flow of metric constraints.

因子分解の次元拡張

$p=1, \dots, P$: 観測点番号

$f=1, \dots, F$: カメラ番号

T_k : 時刻

$n=1, \dots, N$: 語彙番号

$l=1, \dots, L$: 状態番号

$$\tilde{x}_{fp} = x_{fp} - \frac{1}{P} \sum_{p=1}^P x_{fp}$$

$$\tilde{x}_{fp} = \mathbf{m}_f^T \mathbf{X}_p$$

$$\tilde{y}_{fp} = \mathbf{n}_f^T \mathbf{X}_p$$

$$\tilde{\mathbf{W}} \equiv \begin{bmatrix} \tilde{x}_1^{(1)} \cdots \tilde{x}_P^{(1)} \\ \vdots \\ \tilde{x}_1^{(F)} \cdots \tilde{x}_P^{(F)} \\ \tilde{y}_1^{(1)} \cdots \tilde{y}_P^{(1)} \\ \vdots \\ \tilde{y}_1^{(F)} \cdots \tilde{y}_P^{(F)} \end{bmatrix}, \quad \tilde{\mathbf{W}} = \begin{bmatrix} \mathbf{m}_1^T \\ \vdots \\ \mathbf{m}_F^T \\ \mathbf{n}_1^T \\ \vdots \\ \mathbf{n}_F^T \end{bmatrix} [\mathbf{X}_1 \cdots \mathbf{X}_P] = \mathbf{M}\mathbf{X}$$

$$\tilde{\mathbf{W}} = \mathbf{M}\mathbf{X}$$

$$\mathbf{C}_p^{(f)} \equiv \begin{bmatrix} c_{1p}^{(f)} \\ \vdots \\ c_{np}^{(f)} \\ \vdots \\ c_{Np}^{(f)} \end{bmatrix} = \begin{bmatrix} \mathbf{r}_1^{(f)T} \mathbf{S}_p \\ \vdots \\ \mathbf{r}_n^{(f)T} \mathbf{S}_p \\ \vdots \\ \mathbf{r}_N^{(f)T} \mathbf{S}_p \end{bmatrix} = \begin{bmatrix} \mathbf{r}_1^{(f)T} \\ \vdots \\ \mathbf{r}_n^{(f)T} \\ \vdots \\ \mathbf{r}_N^{(f)T} \end{bmatrix} \mathbf{S}_p = \mathbf{R}^{(f)} \mathbf{S}_p = \begin{bmatrix} r_{11} \cdots r_{1l} \cdots r_{1L} \\ \cdots \cdots \cdots \\ r_{N1} \cdots r_{Nl} \cdots r_{NL} \end{bmatrix} \mathbf{S}_p$$

(N×P)

$$\mathbf{C} = \mathbf{R}\mathbf{S}, \quad \mathbf{S} = \mathbf{R}^{-1}\mathbf{C} = \mathbf{Q}\mathbf{C}$$

$$\bar{\mathbf{W}} = \overline{\mathbf{M}\mathbf{X}} = \begin{bmatrix} \mathbf{M} & \mathbf{A} \\ \mathbf{B} & \tilde{\mathbf{Q}} \end{bmatrix} \begin{bmatrix} \mathbf{X} \\ \mathbf{C} \end{bmatrix}$$

$$\bar{\mathbf{W}} \equiv \begin{bmatrix} \tilde{\mathbf{W}} \\ \tilde{\mathbf{S}} \end{bmatrix} = \begin{bmatrix} \tilde{\mathbf{W}} & (2F \times P) \\ \tilde{\mathbf{S}} & (LF \times P) \end{bmatrix}$$

$$\tilde{\mathbf{W}} \equiv \begin{bmatrix} \tilde{x}_1^{(1)} \cdots \tilde{x}_p^{(1)} \\ \vdots \\ \tilde{x}_1^{(F)} \cdots \tilde{x}_p^{(F)} \\ \tilde{y}_1^{(1)} \cdots \tilde{y}_p^{(1)} \\ \vdots \\ \tilde{y}_1^{(F)} \cdots \tilde{y}_p^{(F)} \end{bmatrix}, \quad \tilde{\mathbf{W}} = \begin{bmatrix} \mathbf{m}_1^T \\ \vdots \\ \mathbf{m}_F^T \\ \mathbf{n}_1^T \\ \vdots \\ \mathbf{n}_F^T \end{bmatrix} [\mathbf{X}_1 \cdots \mathbf{X}_p] = \mathbf{M}\mathbf{X}$$

$$\begin{aligned} \mathbf{S}_1^{(1)} &= [\mathcal{S}_{11}^{(1)}, \cdots, \mathcal{S}_{l1}^{(1)}, \cdots, \mathcal{S}_{L1}^{(1)}] \\ &\vdots \\ \mathbf{S}_p^{(1)} &= [\mathcal{S}_{1p}^{(1)}, \cdots, \mathcal{S}_{lp}^{(1)}, \cdots, \mathcal{S}_{Lp}^{(1)}] \\ &\vdots \\ \mathbf{S}_P^{(1)} &= [\mathcal{S}_{1P}^{(1)}, \cdots, \mathcal{S}_{lP}^{(1)}, \cdots, \mathcal{S}_{LP}^{(1)}] \end{aligned}$$

$$\tilde{\mathcal{S}} = \begin{bmatrix} \mathcal{S}_{11}^{(1)}, \dots, \mathcal{S}_{1p}^{(1)}, \dots, \mathcal{S}_{1P}^{(1)} \\ \vdots \\ \mathcal{S}_{11}^{(F)}, \dots, \mathcal{S}_{1p}^{(F)}, \dots, \mathcal{S}_{1P}^{(F)} \\ \dots\dots\dots \\ \mathcal{S}_{l1}^{(1)}, \dots, \mathcal{S}_{lp}^{(1)}, \dots, \mathcal{S}_{lP}^{(1)} \\ \vdots \\ \mathcal{S}_{l1}^{(F)}, \dots, \mathcal{S}_{lp}^{(F)}, \dots, \mathcal{S}_{lP}^{(F)} \\ \dots\dots\dots \\ \mathcal{S}_{L1}^{(1)}, \dots, \mathcal{S}_{Lp}^{(1)}, \dots, \mathcal{S}_{LP}^{(1)} \\ \vdots \\ \mathcal{S}_{L1}^{(F)}, \dots, \mathcal{S}_{Lp}^{(F)}, \dots, \mathcal{S}_{LP}^{(F)} \end{bmatrix}$$

$$\bar{\mathbf{W}} = \begin{bmatrix} \mathbf{m}_1^T & 0 \dots 0 \\ \vdots & \\ \mathbf{m}_F^T & \\ \mathbf{n}_1^T & \\ \vdots & \\ \mathbf{n}_F^T & \\ 0 \dots 0 & \tilde{\mathbf{q}}_1^{(1)T} \\ 0 \dots 0 & \end{bmatrix} \quad [\bar{\mathbf{X}}_1 \dots \bar{\mathbf{X}}_P] = \bar{\mathbf{M}}\bar{\mathbf{X}}$$

$$\bar{\mathbf{W}} \equiv \begin{bmatrix} \tilde{\mathbf{W}} \\ \tilde{\mathcal{S}} \end{bmatrix}, \quad \bar{\mathbf{W}} = \bar{\mathbf{M}}\bar{\mathbf{X}} = \begin{bmatrix} \mathbf{M} & \mathbf{A} \\ \mathbf{B} & \tilde{\mathbf{Q}} \end{bmatrix} \begin{bmatrix} \mathbf{X} \\ \mathbf{C} \end{bmatrix}$$

$$\bar{\mathbf{W}} = \bar{\mathbf{M}}\bar{\mathbf{X}} = \begin{bmatrix} \mathbf{M} & 0 \\ 0 & \tilde{\mathbf{Q}} \end{bmatrix} \begin{bmatrix} \mathbf{X} \\ \mathbf{C} \end{bmatrix}$$

15.1 非負値行列因子分解の検討

さらに導出される属性値に非負の条件を課せば、近年注目される非負値行列分解（Non-negative Matrix Factorization） $[11]$ となる。以下、これらについて簡単に予備実験を行ったのでその結果を示す。

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